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SHELL BOOK
BY
JULIA E. ROGERS

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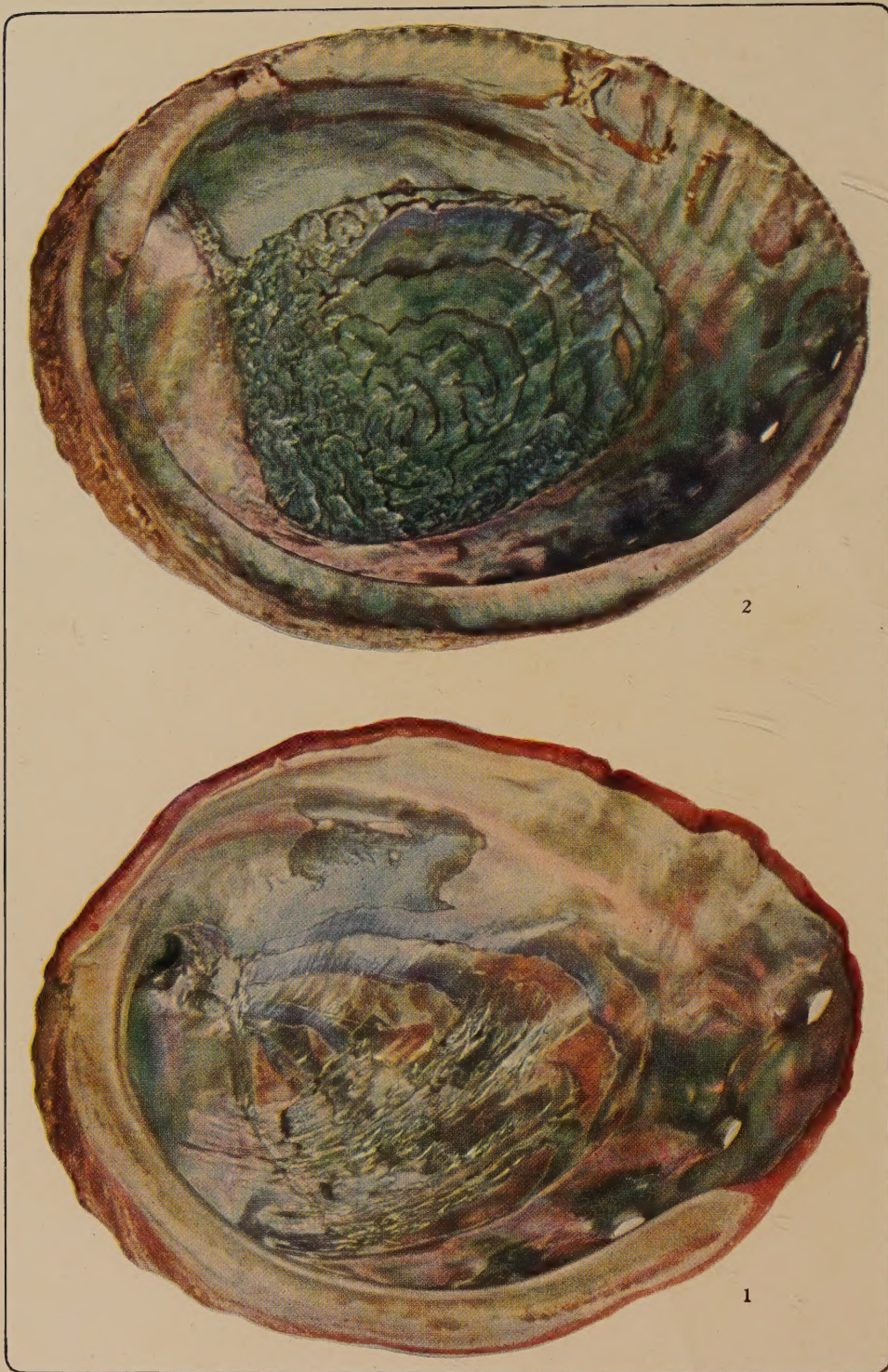
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ABALONES OF THE CALIFORNIA COAST

2 Splendid Abalone, *Haliotis fulgens*, Phil.

2 Red Abalone, *Haliotis rufescens*, Swains.

THE SHELL BOOK

A POPULAR GUIDE TO A KNOWLEDGE
OF THE FAMILIES OF LIVING MOLLUSKS,
AND AN AID TO THE IDENTIFICATION
OF SHELLS NATIVE AND FOREIGN

BY

JULIA ELLEN ROGERS

Author of "The Tree Book"

EIGHT PLATES IN COLOUR, AND NINETY-
SIX IN BLACK-AND-WHITE MOSTLY FROM
PHOTOGRAPHS BY A. R. DUGMORE



GARDEN CITY NEW YORK
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ALL RIGHTS RESERVED
INCLUDING THAT OF TRANSLATION INTO FOREIGN LANGUAGES
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TO MARION, FRANCES, AND GORDON, YOUNG
CONCHOLOGISTS OF THE NEW SCHOOL, MY
COMPANIONS ON THE SEA BEACH DURING A
BEAUTIFUL WINTER IN SOUTHERN CALIFORNIA,
THIS BOOK IS AFFECTIONATELY DEDICATED

PREFACE

EVERY person interested in shells has felt the need of a manual of the shell-bearing animals of sea and land, comparable to the comprehensive manuals provided for those who wish to study birds or insects or trees. Small hand-books serve as guides to the seashore, but they treat only detached portions of the great kingdom, Mollusca. What is needed for more serious study is a larger book in which the families of mollusks are arranged in their proper order, to give a general idea of the size and scope of the important genera, and their natural relationships. Such a popular guide should give precedence to the accepted English names of the families and of the individual species described, while attaching to each its scientific name. It is quite possible to give the general reader the information he desires in his own language, without sacrifice of scientific accuracy.

A book of this kind must be the outgrowth of extensive acquaintance with living mollusks in their natural surroundings, or it will be as dead as the shells in a cabinet, and dry as the dust on the old shell catalogues. It must bring together as much as can be found out about the habits of the mollusks described, and the uses people make of them, if they have any economic value. Many shells have never yet been seen alive; others are - practically unknown. It is astonishing how little is known about many species of mollusks.

The standard literature of conchology has a limited circulation. The classics are rare and sumptuously illustrated volumes locked up in glass cases in the great libraries. These are out of date, of course. The newer treatises are expensive and very technical. Many facts of the highest interest and value are hidden away in official reports of scientific expeditions, not easily obtainable nor easily read by anyone untrained in the sciences.

If I have failed in my attempt to make an interesting and useful shell book, it is not because conditions were unfavorable for my purpose. Everything and everybody worked together to help me.

Preface

In the first place I learned the difficult art of doing nothing, by which alone one can get on in studying the life of the seashore. For a long and leisurely summer cruise on the Gulf coast of Florida I have to thank the hospitable skipper of the houseboat *Irene*, Mr. A. W. Dimock, who judged shell study the proper foil for the more active pursuit of playing the leaping tarpon before a camera. Through his inspired suggestion and invitation, this book became a possibility. On the sub-tropical beaches of uninhabited islands time stood still, and a vast Floridian leisure possessed my soul. Beyond fishing, when the sun and tide were right, no more exacting demands were made upon me than to answer the dinner horn and to go into the water when it rained. On those tide-washed shores I found at home the bright-hued creatures I had met before only in books — the most varied and most beautiful assemblage of shells to be found on any beach belonging to the United States.

The sober-coloured east coast shells I have studied on rocky and sandy shores from Old Point Comfort to Casco Bay. My teachers have been children and sages — clam-diggers of Cape Cod, grizzled old oystermen of Long Island, men of science and veteran collectors of the Marine Biological Laboratory at Woods Holl, Mass. The hospitality of Dr. and Mrs. Frank Overton, of Patchogue, L. I., made most pleasant and profitable my study of the oyster industry of Great South Bay. Dr. and Mrs. Henry M. Dean showed me similar kindness when I, a stranger, went to see the making of pearl buttons from the shells of river clams in the factories at Muscatine, Iowa.

On the Pacific coast Professor Josiah Keep and the group of conchologists that centres at Los Angeles, showed me many kindnesses. My greatest debt is to Mr. and Mrs. T. S. Oldroyd, of Long Beach, well known to conchologists and collectors. Besides giving me access to their unexcelled collection of west coast shells, they spent much time with me on the rich collecting grounds they know so well in the neighbourhood of San Pedro Bay. The Los Angeles Public Library bought a complete set of the rare and costly "*Conchologia Iconica*," by Reeve (in twenty quarto volumes, illustrated by 2,600 plates coloured by hand) in order that work on the book might progress during my winter in Southern California. For this unusual favour I thank Mr. C. J. Lummis, librarian, and Dr. C. J. K. Jones, director of study and research.

Through the kindness of Mr. C. H. Townsend, Director of the New York Aquarium, I have had opportunity to study many mollusks alive in the fish tanks, and in the remarkable series of balanced aquaria, in charge of Mr. L. B. Spencer.

At the American Museum of Natural History, with its magnificent collection of shells and its library, every facility for study has been at hand. Particular thanks are due this Museum, the officers of which selected and placed at Mr. Dugmore's disposal the shells from which the color and half-tone illustrations were made. Dr. Louis P. Gratacap, Curator of Conchology, has read the book critically in manuscript, and given me, on all occasions, his broad knowledge of the subject and the benefit of his judgment on disputed points. I am also indebted to Mr. Maxwell Smith for painstaking research and for the use of material from his private collection.

The plan and nomenclature of this book follow the accepted standard, "The Manual of Conchology," by Tryon and Pilsbry. The shifting of the Cephalopods to fourth place instead of first is justified, I think, in a shell book, because, with the exception of the chambered nautilus, these mollusks are destitute of true, external shells.

JULIA ELLEN ROGERS.

New York, February 1, 1908.

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PART I
HOW TO KNOW SHELLS

THE SHELL BOOK

CHAPTER I: HOW TO KNOW SHELLS

ALL up and down the ocean border, east and west and south, I have met people picking up shells. Children and grown people both give themselves to the eager search for ocean treasures left by the outgoing tide. The fascination of the pursuit—who has not yielded to it? Who ever came back from a walk on the beach without at least a handful of shells too irresistibly pretty or interesting to leave?

Ask the name of a shell and the reply is almost invariably: "It's some kind of clam," or, "It's some kind of snail." Few grown people regard with any feeling but distaste, if not disgust, "the slimy thing inside." Apparently they distrust the statement that the shell is but the skeleton of the living mollusk it protects.

It is not surprising that a popular misconception exists as to the origin of shells. Even scientists devoted to conchology used to discard the soft parts without considering their structure. The shell was the thing. On its characters alone classification was based. Now the whole mollusk is the thing, shell and all. The name is from the Latin adjective *mollis*, which means *soft*. Some mollusks have no shells at all. Most of them have shells for protection of their soft bodies, but they do not build them, as bees make comb of wax and the white-faced hornet builds her paper palace. Mollusks are shell-builders in the same sense that you and I are bone-builders. The fleshy mantle of the mollusk secretes lime from the water and adds it, layer by layer, to the growing shell. The horny skin outside and the pearly or enamel lining protect the shell substance from the corrosive action of acids in the water.

When we consider how little was known a hundred years ago about plants and animals compared with what the century has

added; and when we think how changed is the attitude of scholars toward sciences to-day, we may well marvel that so much has been accomplished in so short a time. Science for its own sake is no such real and vital thing as science in its relation to human life. A great popular interest in natural sciences has followed the lead of scientists. Generations of Nature-lovers are coming on.

Conchology, as the name confesses, was the science of shells. In 1800 two thousand species of shells were known. Now fifty thousand species of mollusks are distinguished by name. The whole specimen is studied to determine its relationships. Its life history and habits are eagerly investigated. Thus has a dead science come to life; and we shall see people opening their eyes more and more to the wonderful forms of molluscan life that are all about them, but which they have not yet learned how to see.

The scope of the Mollusca is great. No other animal group has so wide and varied a range of distribution. All latitudes have their peculiar genera and species, excepting only the extreme polar regions. Land shells range from tide water to snowy mountain tops, to the limits of animal and vegetable life. Lakes and rivers teem with fresh-water forms. Amphibious mollusks cluster where land meets water. From the populous ocean border a diminishing list of marine forms live on the ocean bed to abyssmal depths. The pelagic mollusks live on the surface of the open sea.

Mollusks there are that climb, leap, crawl, burrow, swim, dive, float, even fly; for the graceful sea arrow which darts out of water like a flying fish, is a squid, and squids are mollusks. There is no mode of locomotion denied them. From microscopic forms they range in size to the ponderous spindle-shell, a marine snail two feet long, and the giant clam, four feet across, weighing five hundred pounds.

As scavengers on the ocean border and inland, mollusks are important agents of sanitation, destroying disease germs in decaying organic matter, thereby purifying water and air. Snails destroy noxious fungi and weeds. Mollusks furnish food to man and other animals. To a large extent they are the food of cod and other fish. Our dependence upon them is no less a fact because it is indirect, as in this case.

Oysters are preëminent among edible mollusks, with clams and cockles, and snails and scallops in a long train after them. An oyster is preëminent, too, as the source of the world's wealth



Photograph by Julian A. Dinock

GATHERING SHELLS IS HALF THE FUN OF A SEASHORE VACATION



BEAUTIFUL SHELLS IN THE GREATEST VARIETY ARE FOUND ON THE BEACHES OF SOUTHERN FLORIDA

Photograph by Julian A. Dimock

in pearls. Mother-of-pearl is the lining of shells. Pearl buttons are cut from shells of the fresh-water clams. Cameos are cut from conchs and helmet shells. Sepia ink and the far-famed Tyrian dyes are molluscan secretions. Royal robes were woven of the threads by which the little pen shell clings to its rocky abode. A little cowrie of handy size and shape is the "money shell" of African tribes, the currency used in all traffic. But these interesting mollusks we can only read about. There are others closer by.

Go with me down to the seashore when the tide is out. It takes time to get the eyes and the mind focused upon what one is looking at. The beach is scattered with the dead shells of its own inhabitants. Between the limits of the high and low tides is a zone of life that follows in and out the curves and angles of the crumbling sea wall. In the tide pools, under the smooth sand, on rocks, under spreading green seaweed, live the creatures of the seashore. They are retiring in disposition. Very naturally they do not wave us a welcome.

How quickly a child throws away a lapful of wave-worn shells to watch the doings of a live one! Do you see that small jet of water spouting upward? The spade thrust deftly under turns out a slim razor clam. Watch or he will dive into the sand before you can get him into the pail of sea water. Fill it half full of sand and how quickly he is out of sight.

What is that ridge on the smooth sand? The boy explores it with his bare toe, and turns out a surprised moon shell. Watch the disturbed creature draw his great foot into the stout shell, and shut the world out with the horny door.

Those familiar "sand collars," so fragile when they are dry, turn out to be the egg-carrier of the moon shell. And the poor clams whose shells are bored with neat round holes near the beaks are victims of the moon shell's voracious appetite. It is easy to prove this by putting the two together alive in the pail and leaving them over night. Sometimes a shell scampers clumsily over the sand instead of sedately plodding along just under the surface. It tumbles over, and reveals a sheaf of jointed arms at the opening. The original owner has been superseded by that inveterate house-hunter, the hermit crab.

There is positively no end to the new discoveries one makes when the eyes are once open to the strange doings of the shore-

dwellers. It is not *study* to watch them. It is one of the finest ways to put in the vacation of a brain-worker. It is true recreation. If the sojourn lasts a week or longer, have a jar of sea water with sandy bottom and some green seaweed to keep it pure. Put the creatures you wish to watch into this aquarium—a miniature ocean—for your convenience and pleasure. Here the shy mollusks will lose their self-consciousness, and live their lives as contentedly and naturally as the bolder ones.

If you live inland you may never achieve a vacation at the seashore. Go to the lake or the stream nearest home. Sweep the edges of the ditch with a dip net. Rake the bottom of the brook and the pond. The number of aquatic mollusks living in such situations is such that you soon abandon the idea that all but a few live in the sea. No marine specimen ever exhibits more intelligence or agility than the little bladder snail that lives on plants in ponds and ditches. Put a few in an aquarium jar in spring. The eggs, then the young, will hold your interest like a play. Through their eventful youth these little gymnasts will migrate in straight lines, at various angles, from one part of the tank to another, on threads of mucus, fine as a spider's web. Their tricks are amazing and amusing, in infinite variety.

The inlander has at hand all the air-breathing mollusks, the land snails of his region. The forest snails hide under loose bark, and under decaying logs. Sun-enduring kinds hide among grass roots, and among more luxuriant vegetation, and fare forth in damp weather or only by night. The number of the land snails is very great, even in our temperate zone.

Little is yet known about the life history of many of these. The limits of distribution are vague and inaccurate for many. When does this snail lay its eggs? How long do the young require to reach maturity? When does that species seal up its doorway and go into the ground to spend the winter? The young conchologist can ascertain the correct name of a specimen by sending it to one of the scientific institutions named on page 8, where a specialist will answer his inquiry. The careful observer, if he keeps a note-book, may discover and pass on to conchologists valuable facts in the life history of little-known species. The study of our land mollusks is very incomplete. It is a worthy and enjoyable opportunity that is open to earnest young naturalists to-day.

It is worth while to make a collection of shells. This is one of the most desirable channels into which to guide the collecting zeal of children. Pennies are better invested in gay-hued sea shells at the curio shop than in the equally dazzling display in the candy shop. I could never doubt the genuineness nor the enduring quality of a child's love for a growing shell collection after spending a winter at Long Beach, Cal., and seeing a child's small hoard of "a window shell, two Muricks (*Murex*) and a *Turritella Cooperi* I found myself!" grow till a small cabinet was needed to display and protect from dust a good variety of native and exotic species. Friends always rally to the assistance of the amateur conchologist. Shell dealers have tropical shells of great beauty at surprisingly small prices. When his experience is wider, the collector can obtain many of the species he desires by exchange with other collectors in different parts of the country, and in foreign countries. To all these resources are added his own industry in his own neighbourhood. Shell collectors are always enthusiasts, and their enthusiasm is likely to become contagious, especially as it is supplemented by study of mollusks alive, in the aquarium and snailery and in their native haunts.

The Golden Age of Conchology was reached in the middle of the last century when Hugh Cuming returned from cruising among the islands of many seas, bringing as spoils of his wanderings thousands of shells of the Tropics, the largest and handsomest to be found in the world. He had twenty-five hundred different species of marine shells, and five hundred species of land shells. Such forms find refuge among groves of many-coloured corals and sea-weeds; the air-breathers hide among tropical vegetation, unseen because as gaily striped as the flowers. Many of these splendid shells were absolutely unknown to science. The tremendous effect they produced upon the shell collectors of Europe cannot be described. Magnificent private collections represented the grand passion of many wealthy and ambitious amateurs. Auction sales were patronised by persons of high social standing, noted conchologists, and shrewd speculators. These were centres of excited competition, where prices of rare and beautiful shells reached surprising heights.

Most of these private collections have been absorbed by great museums, where they are displayed for the enjoyment of the public, or are at least available to those who wish to study them.

How to Know Shells

The great collections of this country are at the Smithsonian Institution in Washington, the Academy of Sciences in Philadelphia and the American Museum of Natural History of the City of New York. Chicago has a fine collection in its Academy of Sciences. Other cities are building up similar exhibits. Colleges and universities, public libraries and local museums house many private collections displayed where the public may use and enjoy them. In connection with the great museums scientists are devoting their lives to research.

Children and others interested in shells should pay occasional visits to some great collection. Conchologists of world-wide fame are very kindly people, eager to help beginners by identifying a perplexing specimen, or by helpful suggestions. Such experiences are enlightening and impressive, and leave very pleasant memories.

After such a visit we come home to our own with new pleasure. We take out the prettiest shells, finger their glossy, curving spires, and delight in their rich harmonies of colouring. We almost love them for their changeless beauty. What must it be like to gaze over a boat's side at the wonderful coral groves where such shells are seen alive! Shall we have the good luck to go some day to Jamaica, or to the Philippines, where live the most beautiful land shells in the world? Or to the East Indian or Panama beaches, with their wonderful marine forms?

Pending the decision of these fascinating questions, let us take a look into the aquarium where the pond snail hangs, shell downward, calmly grazing the green scum from the top in an irregular swath. In the snailery the hungry ones have found our offering of lettuce leaves. Outside, along the garden path, in the cool stillness of the summer twilight,

Stoop to watch the tube-eyed snail
Creep o'er his long, moon-glittering trail.

The life story of the most wonderful of tropical mollusks is not more interesting than that of the humblest snail that takes toll of our vegetable garden.

CHAPTER II: THE BALANCED AQUARIUM AND THE SNAILERY

A PRACTICABLE WAY TO STUDY MOLLUSKS ALIVE IN YOUR OWN HOME

ABOUT fifty years ago a young lady up in Vermont took home from a pond a two-quart glass jar of water in which she had collected a few tadpoles, minnows and snails, and some of the growing pond-weed among whose leafy stems she found them. In her home she kept this happy family; the water did not stale and grow turbid; the animals and plants thrived as if they were still in their native pond.

The secret of her success was this. The leaves of submerged plants give out oxygen which gill-breathing animals obtain from the water. They take up the carbonic acid gas given off into the water by the animals. Each kind of living thing needs the very element that the other discards. Plants and animals "purify the water" for each other. This balance of Nature is a nice one. Too many animals or too many plants upset it.

Fresh water aquaria are miniature ponds, tanks or jars stocked with animal and plant life brought in from ponds or streams. If properly "balanced," the water needs no changing but remains pure and sparkling as long as the equilibrium is maintained. This is the practicable aquarium for all who live inland.

Marine, or salt water aquaria are feasible for all who live near the seashore. The law of balance holds here, too. The difference is that sea water is used, and seaweeds and the animal life of the ocean furnish the proper materials for stocking it. Inland, there have been some successful marine aquaria. But it is expensive to ship sea water by rail, and making artificial sea water presents many difficulties. The stocking of these aquaria is precarious business. Successful marine aquaria inland are rare.

Public aquaria, like the great institution in Battery Park, New York, which is visited by thousands of people daily, maintain

The Balanced Aquarium and the Snailery

full-grown specimens of various animals that live in the seas as well as in rivers and lakes. For such, the water in the tanks requires constant change, or the inhabitants would die. There is a pipe bringing in a fresh supply, and an exhaust pipe carrying off the excess in each tank. The greater the surface, the better chance for fresh air, which plants and animals all need. Many animals come to the surface for air. The best aquarium imitates the pond in having the largest possible surface in proportion to its depth.

A tank fitted with running water is too elaborate and too expensive an outfit for home use. The care of it soon becomes a burden.

The Home-made Tank.—The image that arises in the average mind is of a tank made of an iron frame, plate glass and cement, with a large rock-work piece in the centre. Through the archways and colonnades, and in and out among waving plumes of water plants there passes a procession of gay gold fishes.

Let me counsel the beginner to curb his aspiration for a home-made tank. Materials cost little, and it looks reasonable to suppose that a good mechanic can put them together successfully by simply following directions. The experience of many an ardent aquarist has been that failures succeed failures, no matter how carefully he has tried to forestall them. "Water is so thin! It will work through anywhere." Changes in temperature, warping of the wood, cracking of glass, disintegration of the cement in spots—these are contingencies that keep the builder of a home-made tank in constant suspense. The leak he anxiously expects for months is sure to come, like a thief in the night, to ruin his hopes. If you must have an aquarium of this type, buy it of a dealer who will guarantee it, or make good, if any faults in construction come to light. Thus risks are minimised, and the owner can sleep o' nights.

Solid Glass Aquaria.—*Rectangular tanks* "made in one piece" are very satisfactory. Examine them before buying, to be sure that objects are seen without distortion through the sides. Choose one as nearly uniform in thickness as possible. The fault of these jars is that in moulding the angles are likely to be thinner than the sides, which makes them liable to crack when the temperature is variable.

Cylindrical tanks, with circular bottoms and perpendicular

sides, are considered the most dependable shape for the home or school aquarium. Many of these are maintained in the New York schools. The slight distortion of the shape and size of an object in the water is its main fault. This is easily forgiven in a tank that gives the maximum of strength for its size. Choose one of even thickness, and perfect clearness, and free from flaws.

Glass globes are beautiful but dangerous. They have too small air surface for the water they contain. Their curved sides act as a burning glass, concentrating the sun's rays, and heating the water. A sun-lit bowl of gold fish is a dazzling object. But the unfortunate creatures are suffering with the heat, blinded by the glare, and suffocating for breath! The owner is unaware that anything is wrong. It is the height of cruelty to animals to set a fish globe or any aquarium where sunshine can strike it.

Three- to eight-gallon sizes are recommended by the best authorities. Smaller ones are feasible for observing the doings of particular animals. Larger ones are unmanageable in a house.

Place the aquarium where the whole family can enjoy it. Set it on a small table, so it can be viewed on all sides. Set the table in front of a north window if practicable, so as to have light, but no direct sunshine. Any window may have the right light if protected by a veranda roof or an awning. If the table has a marble or metal top, set the aquarium on a wooden base, to prevent danger of cracking.

Stocking the Fresh Water Aquarium.—First put into the (perfectly clean) tank two inches of coarse gravel which has been thoroughly washed. "Bird gravel" is not so good as a coarser grade. Put in bits of rock that please your fancy, a piece of rock work if your taste leans toward artificial structures.

Plants with good root systems are easily anchored in the gravel. Others may be attached to sinkers of some kind which will hold them down. A cluster of stalks may be wrapped with a strip of sheet lead and planted in the gravel. Choose vigorous young specimens, of not too many kinds. Three or four are plenty, and do not crowd the tank. Let each plant display its good points. Give it room to grow.

The "Fontinalis" of aquarists (*Antipyretica fontinalis*) is a feathery moss-like plant that grows on decayed logs or on stones in the beds of streams or by springs. This is a most beautiful and useful plant for the aquarium. It can be found, and it keeps

growing, the year around; and it is one of the few *best* aërotors of water.

The Milfoil (*Myriophyllum spicatum*) ranks next. Its plume is rounded and full. It has the fault of dying away at intervals.

The Hornwort (*Ceratophyllum demersum*) resembles the milfoils, and it lasts longer.

The Eel-grass or Tape Grass (*Valisneria spiralis*) has narrow flat leaves, like green ribbons. It is an intensely interesting study, as well as a valuable tenant of the aquarium. It takes root easily, and throws up vigorous new shoots. At blooming time the solitary buds of the fertile plants rise to the surface on slender coiled stems. The sterile flowers tumble off of their short stems and rise to the surface. Floating about, these pollen-bearers brush against the pistils of the fertile flowers, thus effecting their pollination. Thereupon the coiled stems draw down the flowers which mature, under water, the seed thus set. The sterile flowers wither.

Water Thyme (*Anacharis Canadensis*) is one of the most vigorous of aquarium plants, and is easily obtained in many regions, where it chokes streams and canals.

Pond weed (*Polamogeton densum*) has a fern-like leaf, and grows well in the tank. Though not so easily obtained as the Parrot's Feather, a close relative which florists grow, it is much more desirable. The latter exhales very little oxygen, though it has a dense, showy plume.

The Stoneworts, *Nitella* and *Chara*, bear tufts of silky hairs that sway most gracefully when a tadpole or a fish flips his tail near by.

Water-silk (*Spirogyra*) is a fine network of green threads, which floats, and is often mistaken for "scum." A hand-glass brings out its beauty.

Duckweeds (*Lemna*) float like pale threads, their minute green leaves flattened on the surface of the water. Many tiny snails and other creatures harbour and forage on them.

Riccia, which looks like a sprinkling of green sawdust, is a good plant.

Conserva is the botanical name of several kinds of algæ, microscopic plants, which appear as a green film lining your tank, especially if it is in a well-lighted place. Fairy ropes of it festoon the walls and connect the plumes of the plants. This is



1 Fresh-water aquarium, with pond snails and pond weeds.

2 Marine aquarium, with hard-shelled clams and sheets of green sea lettuce.

The water in these tanks is kept pure by the plants.



Photograph by Maxwell Smith

A GOOD LOCALITY FOR FRESH-WATER MOLLUSKS

one of the useful aëratōrs, and a favourite food of certain snails. It can be checked in its growth by introducing more snails, or by cutting off the light with a screen of yellow paper. Such a method is much better than darkening the room.

Probably no single locality would furnish all the pond plants mentioned. But any natural pond should supply plenty of three or four kinds.

If possible get water from the pond which grew the plants. If this is impracticable, use ordinary well or cistern water, or take it from the city tap.

Let the plants get used to their new station before you put in the animals. Bubbles of air rising in the water show that all is well.

Mollusks of rivers and ponds are at home in the fresh water aquarium, and live at peace with many other animal forms. Snails will be found among the leaves and stems of floating and submerged plants.

The Pond Snails (*Physa*), one of the best kinds for the aquarium, will mow the conferva from the sides of the tank and will breed there, undisturbed, though fishes prey upon them.

The Trumpet Snail (*Planorbis*), coiled flat like a watch spring, a far lustier fellow, may be found in ponds and ditches.

Lymnæa is the name of several pond snails, whose dark, handsome shells coil to the right. They are inactive, a contrast to the ambitious, left-handed Physas.

Paludina, the marsh snail, may be represented sparingly.

Clams will live quietly in the aquarium, travelling about when they feel like it, ploughing with extended foot through the gravel.

Fishes, tadpoles and the little acrobatic Water Newt (*Triton*) live happily with the snails and clams, if fed regularly. Sticklebacks will build nests and hatch their young. Avoid fish over three inches long.

Crayfish are best kept in separate jars; they are beasts of prey and disturbers of the peace, attacking the fish and uprooting the plants. With bits of rock they build caves in which to hide.

Small bits of meat will be eaten by crayfishes and tadpoles. Insects, including "wigglers" from a neglected rain barrel (mosquito larvæ) will be eaten by the fishes. They will pick up bread crumbs. Small creatures we overlook entirely furnish food for larger animals.

Jars containing four or five gallons of water should maintain three or four fishes, two to three inches long, with four or five newts, three or four small tadpoles, six or eight snails and two or three clams. One or two plants extending their tops up out of the water will be appreciated by the newts, which like to take a breath of fresh air occasionally. Snails, too, and tadpoles, enjoy this chance of a change.

Stocking the Marine Aquarium.—First cover the bottom of the tank with an inch of cleaned beach gravel. Pebbles of various sizes add to the beauty of this foundation and offer lodgment for anemones. Fill with the purest sea water obtainable.

Sea lettuce (*Ulva latissima*) is the most desirable plant for the marine aquarium. Collect from tide pools on the beach bits of shell and rock fragments to which are attached young plants of it. Arrange them on the foundation of sand. Broad bands of this plant may be floated on bits of cork at the surface, and anchored at the bottom for a green background against which to see the animal life to best advantage.

Solieria chordalis has brilliant, crimson, wiry branches in profuse bunches, a beautiful contrast to the cool green *Ulva*. It grows on rocks and shells at a few fathoms depth.

Grenella Americana, with narrow red ribbons, is a good plant, if young specimens are used.

Many beautiful seaweeds have proved to be harmful in the aquarium. Those named above are perfectly safe. Aëration is accomplished by *green* plants, — so the *Ulva* is our dependence for oxygen supply. Let the aquarium with its plants have a few days' rest before putting in the animal life.

Corals, even tropical kinds, live comfortably in the balanced aquarium for years. A cold water species is to be had in Long Island Sound and on the Jersey coast about Long Branch.

Oysters, mussels and clams live comfortably in the sand and gravel. Sea anemones "blossom," attached to stones and shells; they are among the greatest attractions of the aquarium.

The Tube Worm (*Cistenides*), in its sandy horn, and *Serpula*, in its twisted limy tube, do well. The Ship Worm (*Teredo*), in a fragment of honeycombed wood, thrives in the company above described.

Botryllus is a coloured, gelatinous mass, with a star-like

arrangement of the individual zoöids, which looks somewhat like coral. It is found attached to eel-grass and to wharf piles.

Sea Squirts are globular, gelatinous creatures that send out a jet of water when disturbed. They will live and multiply in the aquarium.

Snails of the periwinkle group (*Littorina*) are scavengers. They eat decayed vegetable matter, and pick up the crumbs dropped by fishes. The Dog Whelk (*Nassa trivittata*) helps at this job of cleaning, and he is an ornament to the tank. But he may drill a hole in the shell, and suck the life blood of your favourite bivalve, reminding you that he prefers fresh to stale food. Beware the Whelk (*Buccinum*), the Moon Shell (*Natica*), and the Drill (*Urosalpinx*), for they will slay without mercy every bivalve you put within their reach.

Hydroids, microscopic creatures of exceeding beauty of form, often mistaken for delicate seaweeds, occur in the aquarium as if spontaneously, attached to the glass sides or to objects inside.

Hermit and horse-shoe crabs, prawns and little blue crabs should be kept in separate jars. They are most interesting and beautiful. But they are too hungry and too selfish to share the quarters of better-mannered creatures.

Do not attempt to put into one jar *at one time* any such number and variety of plants and animals as I have described.

Understock, rather than *overstock*, the aquarium.

Put in fresh water, as evaporation lowers the level.

Feeding the Animals.—Mince a fresh clam or oyster and feed the sea anemones and corals, by holding a bit on the end of a sharp stick in front of the disk, where the tentacles can reach it. They take it eagerly. The juice lost to the water will feed the bivalves. Cease to offer it, when food is no longer taken. Feed regularly. Bits of meat or clam are good food for the carnivores, which cannot be trusted in the general aquarium.

Cleaning the Aquarium.—Dust may be removed from the surface of the water by skimming with pieces of clean white blotting paper. If dead leaves foul the water, put in more water snails, found among decayed leaves on the edges of ponds and ditches. Slime-covered corners of the same pond furnish you the kind of snail which will clean the scum off the sides and surface of your tank quickly. There are marine snails that will do the same work in the salt water aquarium. When such means

fail, a swab of flannel, wrapped close on a small block, curved to fit the sides of the jar, and affixed to a handle of convenient length, is the best cleaning tool. Wash the dirt out of the flannel after drawing it once up the glass side.

A half-inch glass tube is used to take up bits of food from the bottom of the tank. With the thumb over one end, place the other close to the refuse. Lift the thumb slightly, and the object will rise in the tube. Close the top again with the thumb while taking the tube out of the water. Never leave bits of food on the bottom of the tank. If you prefer, put a hungry crayfish or crab in to clear up the garbage. But don't forget to take him out when his scavenger work is done. He is a dangerous visitor to leave there long.

Plants must be removed when they show symptoms of old age. Animals, too, must be watched, and removed when they are unhealthy. Sick animals often hide under the rocks to die. Hunt them out before they foul the water.

Sometimes turbid water may be cleared by *dipper aëration*. Dipping the water, and pouring it slowly back, with the dipper held six or eight inches above the surface, mixes fresh air with the water, and thus "makes it alive." This should be done carefully so as not to dislodge the plants, nor otherwise disturb the arrangements. Do not empty the tank until all expedients have failed.

Use a siphon to draw off the water, if it has become stagnant. Carefully wash the jar, the gravel, and other contents that are to be replaced. Install plants and animals in clean fresh water. Try to avoid the necessity of another such housecleaning.

Tools Needed for the Aquarium. — Handling fish and other creatures is often the cause of their death. Moreover, it is not pleasant to roll up a sleeve and dive to the elbow into an aquarium. The tools needed are few and simple. Supply these, and so avoid damage and discomfort.

1. A small dip net on a long handle, useful for the transfer of any animal from one tank to another.
2. A pair of wooden forceps long enough to reach objects on the bottom of the jar, useful in rearranging rocks, anchoring plants, etc.
3. A glass tube for taking up refuse.
4. A long, pointed stick for feeding corals, etc.
5. A long-handled swab for cleaning the inside of the jar.

6. A siphon, or merely a piece of soft rubber tubing, to draw off the water in emptying tank.

Much elaborate and unnecessary equipment is offered by dealers in aquarium supplies. The essentials are named above. Most of these articles can be made at home; the others may often be bought at a drug store.

Wholesale houses carrying druggist's supplies usually can furnish such jars as are required. There are several firms in New York City.

THE SNAILERY

Intimate acquaintance with air-breathing mollusks can be cultivated only by bringing specimens from their native haunts into our own homes. Here they will be perfectly comfortable if their surroundings are made homelike. A snailery may well be a glass jar like the aquarium in size and shape. Put in a layer of woods earth three or four inches deep. Plant a few ferns or other woodsy things, and a clump of damp moss; sink a small dish of water in a corner, and screen the top to keep the snails from escaping. Stock this little molluscan terrarium with the snails common to your nearest woods. Feed them bits of tender lettuce, which out of season you can grow in a flower-pot. In the autumn the snailery may be set on a veranda where the feeling of approaching winter will cause the snails to go into hibernation, secreting a parchment doorway after burying themselves just under the leaf mould.

In June the eggs may be found in masses or ribbons in both aquarium and snailery. The development of the young snails is one of the most interesting things to watch. The modes of travel, eating habits, the use of the tentacles, foot, and other parts are best observed as the snails crawl on the glass sides of the jar. Few phenomena are more interesting than the prompt thrusting out of the jaw and toothed tongue of a hungry white-lipped snail when it is offered a bit of cabbage or lettuce.

Carnivorous species in a snailery will devour the vegetable feeders. Keep watch for these, and exclude them. We have comparatively few of these, and a sharp lookout will soon discover the cannibals.

PART II
UNIVALVES AND CHITONS. CLASS
GASTEROPODA

CHAPTER I: A TYPICAL UNIVALVE MOLLUSK

THE Pear Conch well exhibits the structure of the univalves. It is abundant from Cape Cod to Florida. On the same general plan all snails are built.

THE SHELL

It is a conical tube spirally wound to the right about a central axis, the columella. The closed, pointed end is the apex; the coiled whorls form the spire. The last coil is called the body whorl, for in it the body lies. The spout-like prolongation is the anterior canal. The spiral channel is the suture. The shell's mouth is called the aperture. The outer lip is opposite the columella, or inner lip. Lines of growth cross the whorls, close together, and parallel to the outer lip. The hairy skin covering the shell when it is alive is the epidermis. Lining the interior is the enamel. Between these is the main shell substance composed chiefly of lime.

When the body is drawn into the shell the aperture is closed by a horny door, the operculum.

Hold the spiral shell of the conch by its long stem, the anterior canal; the apex is pointed upward; the aperture is at the right. The anterior parts of the body reach the aperture; the posterior parts extend towards the apex. The ventral part of the body is underneath when the foot is extended. It is the inner, short side of the coil. The dorsal part is the arch of the body, the long, outer side of the coil. These terms are necessary to designate the relative positions of the internal organs.

THE SOFT PARTS

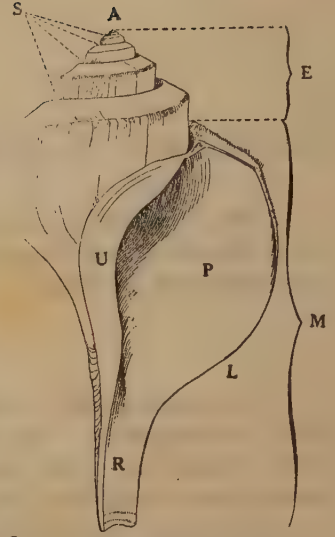
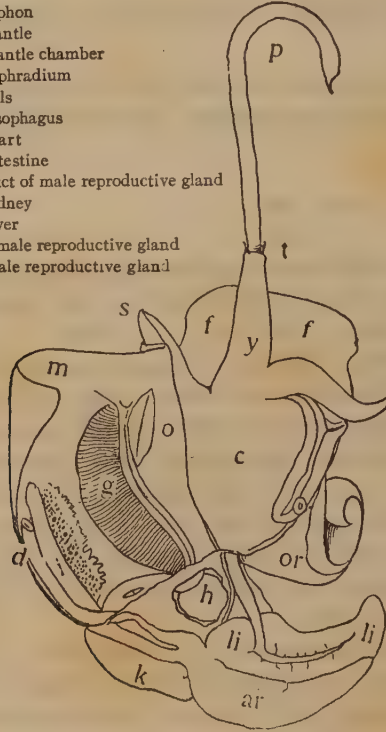
The mantle is the fleshy web that covers the body and lines the shell. In the spire it is attached to the body, and is very thin. In the body whorl it is free from the body, and encloses the mantle cavity. It forms a thickened collar around the body, and fits the shell aperture. This collar is attached at

A Typical Univalve Mollusk

SOFT PARTS OF A UNIVALVE (Mantle chamber laid open)

Pyrula sp.

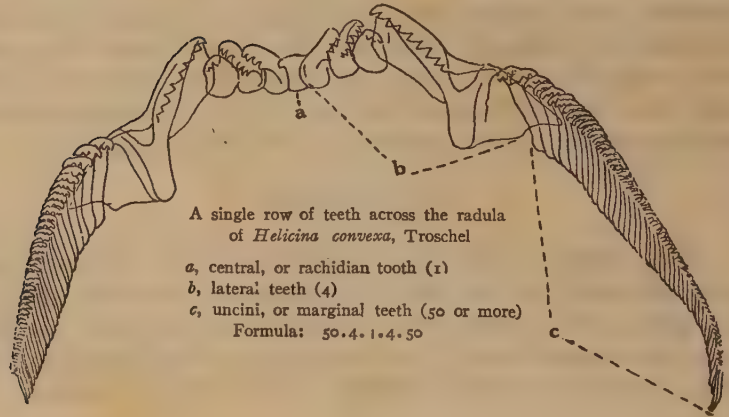
- p*, proboscis
- t*, tentacles
- f*, foot
- s*, siphon
- m*, mantle
- m-c*, mantle chamber
- o*, osphradium
- g*, gills
- y*, cesophagus
- h*, heart
- i*, intestine
- d*, duct of male reproductive gland
- k*, kidney
- li*, liver
- or*, female reproductive gland
- ar*, male reproductive gland



A TYPICAL UNIVALVE SHELL

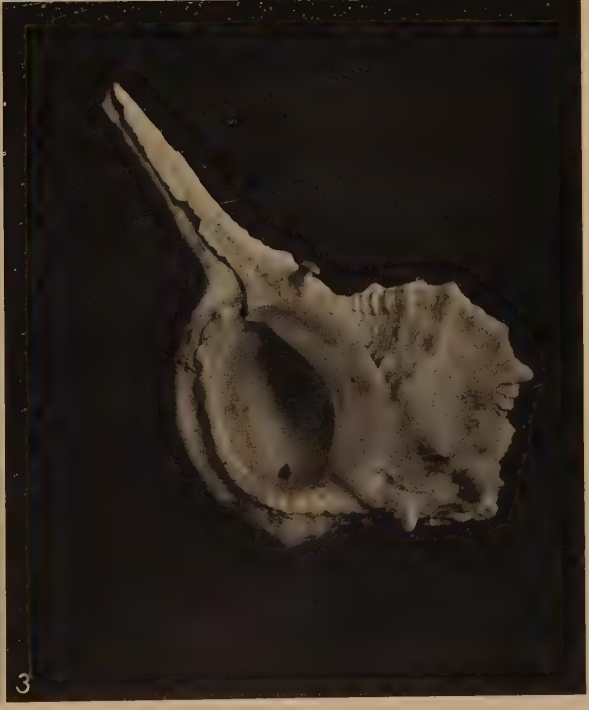
Pear Conch, *Fulgur canaliculata*

- A*, apex
- S*, suture
- B*, shoulder of whorl
- E*, spire
- M*, body whorl
- U*, columella or inner lip
- L*, outer lip
- P*, aperture
- R*, anterior canal



A single row of teeth across the radula
of *Helicina convexa*, Troschel

- a*, central, or rachidian tooth (1)
 - b*, lateral teeth (4)
 - c*, uncini, or marginal teeth (50 or more)
- Formula: 50.4.1.4.50



MUREX SHELLS

1 Venus's Comb, *Murex tenuispina*.

2 Burnt Murex, *M. adustus*.

3 Golden Mouth Murex, *M. chrysostoma*.



ROSE-BRANCH MUREX SHELL, *Murex palma-rose*.

A Typical Univalve Mollusk

certain points in the margin, folded and prolonged at others. The large opening permits the foot to protrude.

The siphon is a tubular prolongation of the mantle, which fits into the anterior canal. The muscular organ that bears the operculum is the foot. The pedal gland opens on the sole, or disc of the foot. An anterior fold of the mantle border forms the head. A central, retractile prolongation, the proboscis, contains the radula—odontophore or rasping tongue—a flexible band set with many transverse rows of teeth, which may be seen protruding from the mouth, at the tip. The central rachidian tooth in each row is flanked by the laterals; on the borders are the marginals or uncini. On each side of the head is an erect triangular projection, the tentacle; each bears a dark eye on the outer edge.

The rounded arch of the body is the visceral dome. The mantle, transparent and thin here, forms the wall of the body. Through it various internal organs are visible. In the first two coils from the apex is a dark mass, the liver. The reproductive gland, brown, red or yellow, overlies the dorsal surface of the liver. The stomach, curved, light-coloured, often indistinctly seen, is just under the surface and overlies the liver on the left. The kidney, somewhat rectangular, yellowish brown to chocolate-coloured, lies on the left side, anterior to the reproductive glands. The yellowish, two-chambered heart lies in a triangular sac, the pericardium, anterior to the kidney.

In females a large yellow nidamental gland lies over the back of the visceral dome, and along the side of the columellar muscle, which fastens the body to the shell. In front of the heart, and extending its overlapping plates into the mantle cavity, is the large, brown gill. The osphradium is a small brownish organ to the left of the anterior end of the gill. To the right of the gill is the hypo-branchial gland.

Slitting open the mantle straight backward along the right side of the gill, and turning back the flaps, the mantle cavity lies open. Here on the right side is the anus, the opening of the intestine, on a short papilla. The opening of the nidamental gland is near by on another papilla, to the right and in front of the anus. The corresponding gland in the male is the testis. The large external male organ which resembles the proboscis, but is shorter, rises on the head behind the right tentacle. The

A Typical Univalve Mollusk

kidney discharges by a narrow slit easily found at the back of the mantle cavity.

The gills are thin and their tubular passages are lined with cilia which continually wave, creating an inward current of water from the mantle chamber. The siphon is always lifted into clear water, no matter if the foot is in the mud, for the water supply of the gills must be clean and constant. In the network of gill passages the oxygen in the water passes into the blood and the carbonic acid gas passes out in the stream of foul water discharged.

The Circulation of Blood. — A vein which brings blood back pure to the heart is found along the left side of the gill. It turns downward at the posterior end of the gill and empties into the auricle. Another vein brings blood from the kidney. The gill receives blood from a vessel that borders its right side. This blood is gathered by smaller vessels from the mantle and from the glandular part of the kidney.

The blood is sent from the ventricle through a short trunk, the aorta, which gives off a large branch, the visceral artery. This branches and distributes blood to the visceral dome. Now the aorta turns downward and forward, enlarges to form the "secondary heart," close to the œsophagus. From this trunk arise several vessels that carry the blood to the foot, the head, the siphon and other organs.

Course of the blood:

1. Heart to the system.
2. System to the kidney.
3. Kidney to gill.
4. Gill to heart.

The auricle is the receiver of the blood. The ventricle is the pump. The pericardium is the loose bag containing the heart. The arteries distribute pure blood throughout the living tissues; the veins collect it impure from these tissues. In the kidney the blood is relieved of its urea. In the gills it receives oxygen and gives out carbonic acid gas. The kidney and the gill are the two organs that relieve the blood of the impurities collected in the living tissues. The blood of mollusks is cold and usually colourless.

The Alimentary Canal. — The mouth is at the tip of the long proboscis; behind it is the straight œsophagus, or gullet, which leads to the stomach. The odontophore has been mentioned

A Typical Univalve Mollusk

before as the radula. This flexible ribbon is closely set with rows of horny teeth. It plays over the end of a central, stiff cartilage rod, by means of muscles attached at both ends, and contracted alternately. Thus holes are drilled in other shells by setting the tip of the proboscis on the surface and drawing the ribbon back and forth.

Two large salivary glands lie near the base of the œsophagus, with ducts to the mouth. The pancreas lies farther back on the right of the œsophagus. The liver is the third gland, furnishing juices that aid in the digestion of food. The stomach and intestine complete the alimentary canal, which discharges its wastes into the mantle cavity.

The Nervous System. — A cluster of paired ganglia (little brains), brown in colour, encircle the œsophagus, three-fourths of an inch behind the base of the proboscis. One pair, the buccal ganglia, sends nerves to the mouth parts. Another pair, the pedal ganglia, supplies the foot. Both pairs are on the ventral side of the œsophagus. On the dorsal side the pleural and cerebral pairs are fused and bound by commissures of nerve fibre with the visceral ganglia; and the last are connected with the abdominal ganglion, a brown mass visible just below the opening of the kidney. The cerebral ganglia are the most centralised "brains" of this mollusk, as they are not only joined, as a pair, but directly connected, by commissures or by contact, with the pedal, buccal and pleural pairs, and through the pleural with the other two. Muscles all over the body are controlled by nerves sent out from these ganglia. Sensations are brought to the nerve centres along nerves from the foot, head, and especially the sensitive mantle border. By these the mollusk learns all it knows of what is going on outside its shell.

The Special Senses. — Snails have eyes, but generally of a low type. Sight is an unimportant sense. The sense of touch is well developed in the mantle margin; the tentacles are touch organs. The mouth has sensitive lips. The osphradium is an organ of doubtful use. It may be the seat of the sense of smell. It is believed to have a composite function of testing the water that passes over it and enters the mantle cavity. Smell is a well developed sense. The condition of the water and its fitness to furnish food and oxygen to the body are broader considerations probably determined by this generalised organ.

A Typical Univalve Mollusk

Hearing is a very poorly developed sense in mollusks. Its special organ has been discovered in many genera of univalves and bivalves. A pair of sacs filled with liquid in which microscopic pebbles float, have nerves connecting them with the cerebral ganglia. There is no denying the auditory function of these organs. As they are imbedded in the tissues, the vibrations received are modified by the medium of the flesh through which they pass. Possibly such impressions ought not to be called sound, but touch, instead.

Taste as a special sense may exist, with nerve ends in the pharynx or back of the mouth.

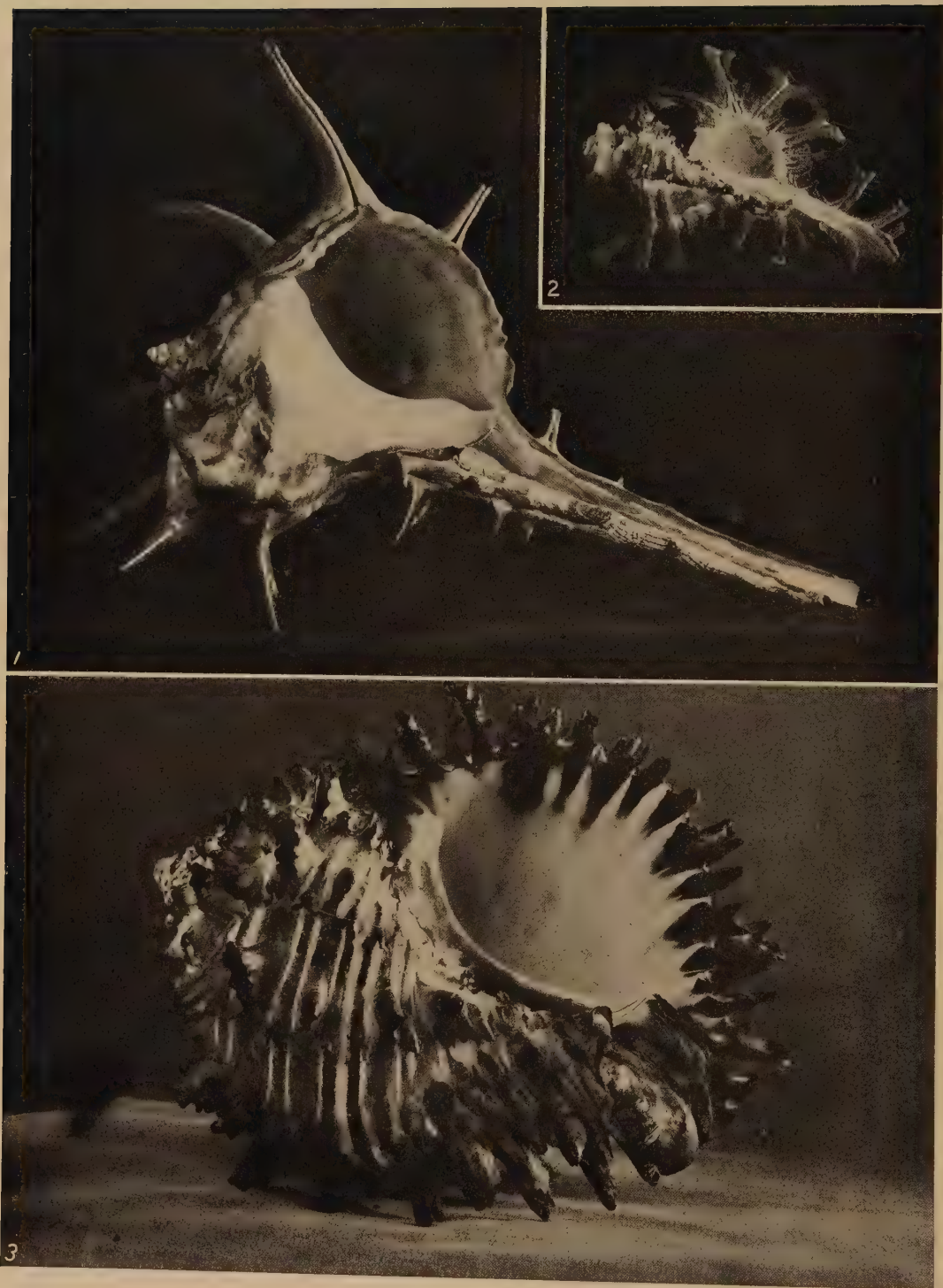


MUREX SHELLS

1 Apple Murex, *Murex pomum*.

2 Operculum of Apple Murex.

3 Branched Murex, *Murex ramosus*.



MUREX SHELLS

1 Horn Murex, *Murex cornutus*.

2 Scorpion Murex, *Murex scorpio*.

3 Root Murex, *Murex radix*.

CHAPTER II: THE MUREX SHELLS. ROCK SHELLS

FAMILY MURICIDÆ

SHELL spiral, fusiform, with anterior canal or notch; whorls thickened by varices or nodules at each rest period of growth; aperture roundish; operculum horny; mantle enclosed, with ruffled border whose extension lines anterior canal; foot broad, simple; eyes present; branchial plumes, two; radula long, slim, with teeth in three series; sexes distinct.

A large family of marine carnivorous mollusks of high organisation, which creep and swim, chiefly in warm seas.

The family Muricidæ is divided by Tryon into two sub-families; I. *Muricinæ*, adorned with varices, having the nucleus of the operculum near the centre; II. *Purpurinæ*, with nodules instead of varices, and with the nucleus of the operculum near the margin.

The genus *Murex* overshadows all the others in size, elaborateness of decoration, and number of species.

Sub-family MURICINÆ

Genus MUREX, Linn.

Shell solid, or pear-shaped, with three prominent spiny or branching varices crossing each whorl, and intermediate ones of smaller size. Canal variable in length, partially closed. About two hundred and fifty species, living from low water to fifty fathoms or more, mostly on tropical or sub-tropical shores of both hemispheres,

The rock shells are distinguished by the striking ornamentation of their whorls by spiny processes. Each varix marks the end of a period of growth, when a barricade is built to guard the temporarily closed doorway. The presence of many secondary

The Murex Shells. Rock Shells

varices is significant: it means comparative starvation for the mollusk, which instinctively strengthens the edge of the shell when threatened with short rations. The most gaily decked murex, therefore, confesses to the greatest struggle for enough to eat. Richness of apparel is the badge of poverty and privation.

Notice the varices on a number of Murex shells. Some are low ridges, scarcely emphasised by tubercles. The majority of species have these knobs prolonged into spines, horns or leaf-like expanses, short and stout, or oftener long, slender, simply or intricately branched. The largest varix fringes the outer lip. Distinct spiral ridges sculpture the spires on every whorl.

The shells are solid, and limy, lined with smooth enamel, never pearly. That part of the outer varix which interferes with growth is eaten off by an acid secretion to make way for the next one.

The colouring of Murex shells is usually rich, the lining flesh pink in many species. The collector of Murex has a long and interesting road to travel, and he has a cabinet of very showy, large, handsome shells for his pains. For some rare species he has had to pay a good price. Some commercial value attaches to Murex shells used by cameo-cutters and makers of fancy shell articles. The flesh of two species is eaten by the peasants on the Adriatic shores.

"The "Tyrian purple" of antiquity was obtained from mollusks of several species of Murex and Purpura. Press the operculum of our humble purple, and a dull red fluid is exuded. It comes from anal glands, and is doubtless protective, like the ink of common squids. Not knowing how to get at it, the Tyrians ground the mollusks in mortar-like hollows in the rocks. The fluid was then separated by squeezing the fleshy parts and discarding the shell fragments. To this was added five or six times its bulk of water, and twenty ounces of soda to each hundred pounds of the mixture. Evaporation from tin or leaden vessels reduced the dye to the desired strength and colour. Wool dyed in this mixture for a few hours was worth \$200 per pound, so expensive was the method of obtaining the colour. The secret of this process, lost in ancient times, was rediscovered centuries later, but the cheaper cochineal and chemical dyes have supplanted all others.

I follow the grouping of species used by Tryon, giving several under each sub-genus, but not attempting to describe all.

TYPICAL MUREX

Shell with three varices bearing long, straight spines; spire elevated; canal long, straight, narrow.

The **Venus's Comb**, or **Thin Spine Murex** (*M. tenuispina*, Lam.) is the most beautiful of all the rock shells, and the most wonderful in structure. The slender, straight canal is twice as long as the body of the shell. The surface is finely sculptured with alternating large and small spiral ribs. These are crossed by six varices, low ridges bearing close-set, slender, curving spines. Three sets are large, the alternating ones, small. All the long spines curve backward at the tips. The longest are on the canal. The series of parallel spines justify the name, "Venus's Comb." These delicate shells are ashy or bluish brown, the aperture marked with dark lines. Length, 6 to 8 inches.

Habitat. — Indian Ocean, Japan, Northern Australia.

The **Bramble Murex** (*M. tribulus*, Linn.) is one of the thin-shelled spiny rock shells, with long, narrow, straight canals. The spines are shorter, not so numerous nor so exquisitely formed and set as those of the Venus's Comb. The shell is more solid and commonplace in every particular. The ribs show faint nodules between the varices, and are often dotted with brown. There is a black-spined variety. Maximum length, 4½ inches.

Habitat. — Red Sea, China, Japan.

The **Three-Spined Murex** (*M. ternispina*, Lam.) strongly resembles the last-named species, but is more delicately built throughout. Each varix bears three prominent spines. Length, 3 to 5 inches.

Habitat. — Indian Ocean, Philippines, China, Japan.

The **Woodcock Murex** (*M. scolopax*, Dillw.) has a long canal. The surface between the varices is smooth and spirally banded with brown. The spines are sharp, slender and curved, the longest ones on the canal. The shell's outline has suggested the popular name. Length, 6 to 9 inches.

Habitat. — Red Sea, Indian Ocean, China Seas.

The **Snipe's Head Murex** (*M. haustellum*, Linn.) continues the idea of fanciful resemblances. It is a typical Murex with a broad body, and an elevated spire on a straight, slender stem.

The Murex Shells. Rock Shells

The varices are low ridges: the spines are reduced in number and size to a few scattered tubercles. The mouth is round and has a sharp, exerted rim. The ground colour is fulvous, with spiral brown lines that widen at the tubercles. The lining is pink. Length, 3 to 4 inches.

Habitat. — Mauritius, Red Sea, Indian Ocean, China, Philippines.

The **Rare Spine Murex** (*M. rarispina*, Lam.) is marked by scattered short spines, with a few long ones on the upper margin of each whorl. The lower half of the canal is quite spineless. Length, $3\frac{1}{2}$ inches.

Habitat. — Indian Ocean.

The **Short Spine Murex** (*M. brevispina*, Lam.), scarcely three inches long, is whitish and has few short, curved spines on the varices. Between these spines each varix is closely tubercled.

Habitat. — South Africa, Red Sea, Indian Ocean, North Australia.

The **Curved-beak Murex** (*M. recurvirostris*, Brod.) has thick, leaf-like varices, crossed by strong spiral ridges, and three secondary longitudinal ridges between. The upper tubercle on each varix is prolonged into a spine. There are usually one or two spines below the aperture. The colour varies from white to purplish brown, with faint bands of darker brown, showing most distinctly in the aperture. The tip of the canal is recurved. Length, 2 to 3 inches.

Habitat. — West Indies, West Central America.

The **Golden Mouth Murex** (*M. chrysostoma*, Gray) has a curved canal, and further resembles the last-named species in its tubercled varices, and rare spines, in size and shape. It is yellowish drab outside; the mouth is lined with bright orange, and bordered with brown.

Habitat. — Gulf of Mexico, West Indies.

Sub-genus PTERONOTUS, Swains.

Shell triangular; varices, three, fin-like or leaf-like; canal curved, closed, usually short.

The **Triangular Murex** (*M. trigonulus*, Lam.) has its apex elevated, and the whole shell spirally ribbed; the varices are flattened ridges, the aperture is round, with a broad, leaf-like wing flaring outward, and following half way down the slim,

curving canal. Colour, whitish yellow, tinged with pink, and spotted with brown. Length, $1\frac{1}{2}$ inches.

Habitat. — Red Sea.

• Sub-genus **CHICOREUS**, Montf.

Shell ovate or pear-shaped; varices, three, leaf-like, sometimes spiny; canal short, curved, wide, nearly closed. Species mainly Oriental; some are West African; others West Indian.

The **Burnt Murex** (*M. adustus*, Lam.) has jet black fronds, short, leaf-like and irregularly spiny, crowding the varices of the stout spire and also the short canal. The underlying colour is brownish white, with rose pink (sometimes yellow) lip and columella. A single large ridge rises between the varices. The spiral ribs are distinct, dark-coloured, and irregularly set with tubercles. Length, $3\frac{1}{2}$ inches.

Habitat. — Indian Ocean, Japan, Philippines.

The **Axis-horn Murex** (*M. axicornis*, Lam.) is one of the most attractive species, owing to the long, branching fronds which adorn its varices. Seen from any angle, a graceful curved arm is lifted from the shoulder of each whorl as if its digitate extremity were beckoning. The revolving ribs are darker than the brownish fronds. The mouth is small and white inside. Length, 2 to 4 inches.

Habitat. — East Indies.

The **Rose-branch Murex** (*M. palma-rosæ*, Lam.) is the most beautiful of this East Indian group. The solid shell is oblong fusiform, with elevated spire strongly grooved and ridged; the varices bearing stout, flattened fronds which spread into bunches of two-parted tips, beautifully branched and rosy-pink above the banded brown of the shell's surface. The columellar lip is closely toothed, a trait by which it may be distinguished from species which resemble it in other particulars.

This Murex will be the delight of collectors always for its graceful shape and flower-like, rosy fronds. Length, 4 or 5 inches.

Habitat. — Indian Ocean.

The **Apple Murex** (*M. pomum*, Gmel.) is an abundant and well known West Indian species. Its surface is rough all over. The three varices are low and tuberculated, with secondary rows of smaller tubercles between them, and crossed by spiral laminae. The large, round mouth has a bright yellow lining. The outer

The Murex Shells. Rock Shells

surface is yellowish brown. The toothed and frilled outer lip bears three brown spots. The columella is wide, with erect edge, brown and faintly wrinkled. The canal is short, recurved and flattened. Length, 4 to 5 inches.

Habitat. — West Indies.

The **Single-tooth Murex** (*M. monodon*, Sby.) has three strikingly long curving spines on each of the varices. One from the upper end of the canal describes a semicircle, curving over the back of the shell. A single strong tooth rises from the lower border of the outer lip. The columella and outer lip are rosy tinted. The exterior is usually brown, with black fronds. There is a white variety. No more elegantly decorated shell exists than this one, with its long, frond-like branching spines, arching in graceful curves from the deeply grooved body of the shell. Length, $4\frac{1}{2}$ inches.

Habitat. — Australia.

The **Branched Murex** (*M. ramosus*, Linn.) is the largest species in the genus, attaining a foot in length, and corresponding weight and solidity. This is a favourite ornament for cabinets and mantelpieces all over the world. The three varices bear rows of recurving spiny fronds, conspicuous for their size and elaborate ornamentation. The outside is white, coloured with brown and circled with fine brown lines. The aperture is rimmed with rose pink. Young specimens are more nearly covered with fronds than old ones. Length, 6 to 12 inches.

Habitat. — Indian Ocean, Red Sea, Central Pacific Islands, Australia, China.

Sub-genus RHINOCANTHA, H. and A. Ads.

Differs from typical Murices in having four or more varices.

The **Horned Murex** (*M. cornutus*, Linn.) is club-shaped with seven varices, each armed with two or three long, hollow, backward-turning horns. The spire is depressed, the walls thin, the body whorl swollen. The surface is finely ridged. The very long canal bears a spiral row of short spines. The colour is ashy brown, or paler. Length, 6 inches.

Habitat. — West Coast of Africa.

The **Straight-spine Murex** (*M. brandaris*, Linn.) somewhat closely resembles *M. cornuta*, but is smaller throughout. Each of its six varices bears two, short diverging spines. This common

Mediterranean Murex is eaten by poor people along the coast, though it is no delicacy. The Tyrian purple was extracted in ancient times by bruising mollusks of this species in pot holes in the rocks along the sea coast.

Sub-genus HOMALOCANTHA, Mörch.

Whorls rounded; sutures deep; varices leaf-like and produced into fingers, dilated at the tips or spiny; canal short, curved, wide, almost closed. Four Oriental species.

The **Scorpion Murex** (*M. scorpio*, Linn.) is remarkable for the finger-like, channelled fronds, flattened into broad tops, that ornament the last of its five varices. The others bear stumpy, straight spines. A deep and wide spiral suture separates the whorls, almost cutting off connection between the body whorl and the spire. The canal is wide and open. Colour, white to chocolate; varices dark-coloured. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat. — Moluccas, Philippines.

The **Windowed Murex** (*M. fenestratus*, Chemn.) is decorated with a regular lattice-work of ridges which intersect at right angles, leaving square dark window-like pits. There are five or six varices, bearing branched orange-yellow spines so delicate as to be broken from most specimens we see. This is one of the elegant fusiform rock shells. Length, $1\frac{1}{2}$ to 2 inches.

Habitat. — Philippines, Red Sea.

Sub-genus PHYLLONOTUS, Swains.

This group differs from Chicoreus in having numerous varices. The more varices, the more chance for elaborate ornamentation of the shell. In this sub-genus the Murex tendency to spiny outgrowths reaches its highest possibilities. The names indicate how these shells bristle with close-set fronds and prickles and laminations.

The **Root Murex** (*M. radix*, Gmel.) is almost globular with short black, triangular spines set close on its ten to fifteen frondose varices. The white ground colour is almost concealed by this black stubble, which leaves only the top of the spire exposed. It looks like some rough tuberous root. Length, 3 to 5 inches.

Habitat. — Panama.

The **Banded Murex** (*M. trunculus*, Linn.), the commonest Mediterranean species, is modest in its pretensions. The keeled

The Murex Shells. Rock Shells

whorls are set with low tubercles or erect cusps. The broad lip is scarcely wavy. The brownish surface has three broad bands of purple, especially bright in the aperture. From these the Tyrian dyes were obtained. Shells are found in heaps along shore, where they were crushed in course of the process. To-day this species is used as food. Length, 3 inches.

The **Cabbage Murex** (*M. brassica*, Lam.) has a stocky shape, with low spire, short canal and swollen body whorl. There are six or eight folded varices, sharply toothed along the edges, and a larger tubercle on the shoulder of each. Groups of flat tubercles lie between the varices. The mouth is wide and pink-lipped, but orange within. Three brown bands encircle the pale surface. The varices are pink at the edges.

This is one of the largest rock shells. It is closely related to the species *princeps*, *regius*, *imperialis*, "nobles," as their names imply. The Panama and West Indian provinces are the homes of several superb species. Length, 6 to 10 inches.

Habitat. — Gulf of California.

The **Endive Murex** (*M. endivia*, Lam.) has a frizzled head, tipped and banded with brown, curly as the most crisp and inviting head of endive. Length, 4 inches.

Habitat. — Philippines.

The **Spine-ribbed Murex** (*M. spinicostata*, Val.) is a handsome West Indian shell, wound with close ridges, and crossed by six or seven varices armed with hollow spines, very sharp and slightly curved. A few dead specimens have been found on the shore at Beaufort, N. C., and southward. So we claim it as an American species. Colour, white with pinkish brown spiral lines; lining, white. Length, 5 inches.

Habitat. — West Indies.

The **Rock-dwelling Murex** (*M. saxatilis*, Lam.) is one of the large, many-variced species, highly coloured and greatly desired by collectors of handsome shells. The spines spread into graceful fronds. Those on the shoulder of each whorl are larger and usually curved. The canal is curved and open, with spines on each side. The body whorl is considerably swollen. The outside is brownish yellow, banded with pink; the aperture rosy-pink, banded with darker colour. Some varieties are deep orange-pink all over. The handsomest ones come from the Indian Ocean, though collectors more recently have found as fine speci-

mens on the west coast of Africa. They reach eight inches in length.

Sub-genus CEROSTOMA, Conr.

Operculum with nucleus lateral; varices, three, wing-like; aperture toothed inside lip, usually with one large tooth near base. Much like *Pteronotus*.

The **Three-winged Murex** (*M. trialatus*, Sby.) is the prize of the collector in Southern California. It is taken by dredging off San Pedro and San Diego. Three flaring, thin, often reflexed wings adorn its spire; its pale surface is banded between the varices with dark brown. The lip tooth is wanting. Length, 2 to 3 inches.

The **Leaf Murex** (*M. foliatus*, Martyn) is white, with chestnut bands, and a pronounced tooth on the lip, which distinguishes it from *M. trialatus*. Length 2 to 3 inches.

Habitat. — Rocky coasts. Sitka to Santa Barbara, Cal.

Nuttall's Murex (*M. Nuttallii*, Conr.) is whitish, or brown, banded with white. The six varices are thick, frilled rolls crossed by fine spiral striæ. The lip has a row of teeth within the aperture, and one large tooth pointing down and outward. Length, $1\frac{1}{2}$ to 2 inches.

Habitat. — California.

The **One-horned Murex** (*M. monoceras*, Sby.) has fewer and larger lip teeth, more tuberculated revolving ribs, less frilling of the varices, lighter colour and a pink interior. Length, $1\frac{1}{2}$ inches.

Habitat. — Lower California.

The **Festive Murex** (*M. festivus*, Hds.) is a familiar shell to collectors in Southern California. I picked them alive from the muddy rocks exposed at low tide along the breakwater in San Pedro Bay. Dingy brownish white and coated with foreign matters they scarcely show the fine brown spiral striæ that cover the surface. The thick whorls bear three ridge-like, crested varices, which are bent backward. The small oval aperture is closed by a horny operculum. The canal forms a short tube that bends back at the tip. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat. — Southern California.

Sub-genus OCINEBRA, Leach

Spire elevated; canal more or less closed; varices numerous, leaf-like, sometimes spinose.

The Murex Shells. Rock Shells

The **Hedgehog Murex** (*M. erinaceus*, Linn.) is the "sting winkle" of the English fisherman, the French "cormaillet" or "perceur." It invades the oyster beds, and destroys young and old, boring through the bivalve shell, and sucking out its soft contents. When the bored shell gapes, crabs, fishes and other sea scavengers devour the solid muscular parts—"pick the bones"—while the more dainty Murex seeks new victims. It never touches dead flesh.

The habits of this depredator of the oyster beds have been thoroughly investigated. Four hours, more or less, are required to drill the hole. The lingual ribbon is set upon a spot near the hinge of the victim's shell. Then the body of the borer is swayed from left to right until a small hole is made by the rasping tongue. Young borers choose young victims; mature individuals choose older ones.

The Hedgehog Murex has four to seven varices, which are wing-like, and crossed by strong cord-like spiral ribs. Sometimes these crossings form prominent nodules; secondary ones and scale-like protuberances occur between the varices, quite justifying the common name by which this creature is known. Other forms have low rounded nodules only. Some lack varices. The shell has a dingy brown colour. The outer lip wears an elegant festooned frill.

Fishermen hunt this enemy in the oyster beds, cutting off its foot above the operculum, and leaving it to die. Length, $1\frac{1}{2}$ to 2 inches.

Habitat. — Norway to the Azores and Black Sea.

The **Brown Murex** (*M. aciculatus*, Lam.) is a sharp-pointed, neatly ribbed and cross-striated brown shell, found on rocks at low water. Its body is scarlet, dotted with yellow. The canal is short, open and recurved. Length, $\frac{1}{2}$ inch.

Habitat. — Channel Islands to Mediterranean and Azores.

Sub-genus *Ocenebra* is well represented on the west coast of the United States.

The **Carved Murex** (*M. incisus*, Brod.) is white, with fine spiral chestnut lines crossing its seven thick, rounded varices. Living among and under *Fucus*, the shells have an olive coating. At the top of each varix is a spine which curls over a deep pit in the suture. This species is found on rocks, eight fathoms deep. Length, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches.

Habitat. — Santa Catalina Island.

The **Mournful Murex** (*M. lugubris*, Brod.) is dull purplish with six rusty brown varices spread out, sometimes forming flat, curved spines. These are usually broken off, except near the outer lip. The shoulder of the body whorl bears the largest spines. Length, $1\frac{1}{4}$ inches.

Habitat. — Santa Catalina Island and Santa Barbara, Cal.

Poulson's Murex (*M. Poulsoni*, Nutt.) has a solid, elongated shell, spindle-shaped, and grayish white, with fine revolving lines of brown. The oval aperture is pink or white. The canal is short and wide open. The varices form faint, irregular swellings. Length, 1 to 2 inches.

Habitat. — San Pedro to Lower California.

The **Furrowed Murex** (*M. foveolatus*, Hds.) is not familiar to collectors. It has seven rounded varices, furrowed by fine striæ. It is a thick, clumsy shell, with a short, curved canal. The columellar lip is produced into a rim. Length, 1 inch.

Habitat. — Sandy bottom, Magdalena Bay, Lower Cal.

The **Lurid Murex** (*M. luridus*, Midd.) is pale, reddish yellow to chocolate-coloured, sculptured with fine sharp spiral lines and faint rounded varices, few in number. Specimens are generally worn. Length, $\frac{1}{2}$ to 1 inch.

Habitat. — Sitka to Southern California.

The **Sculptured Murex** (*M. interfossus*, Cpr.) is more angled at the shoulders, and narrower. The surface is deeply cut into lattice work by the crossing of the varices and the spiral striæ. Canal short, recurved. Colour, dingy gray. Length, $\frac{1}{2}$ to $\frac{3}{4}$ inch.

Habitat. — Sitka to California.

Frick's Murex (*M. Fricki*, Crosse) has slight, thin, frilled varices, and is elongately fusiform, with seven whorls. The aperture is small; the canal short and recurved. The outer lip spreads into an elegant wing-like frill. Pale, with three wide purplish zones. Length, $\frac{3}{4}$ inch.

Habitat. — California.

CHAPTER III: THE OYSTER DRILL

FAMILY MURICIDÆ

Genus UROSALPINX, Stimps.

SHELL elongated, oval, longitudinally ribbed or undulated, spirally striated; varices none; aperture ending in short canal; outer lip toothed, operculum semi-cordate, nucleus lateral and a little below middle; lingual ribbon well developed; ova capsules oblong, shouldered, widest near top.

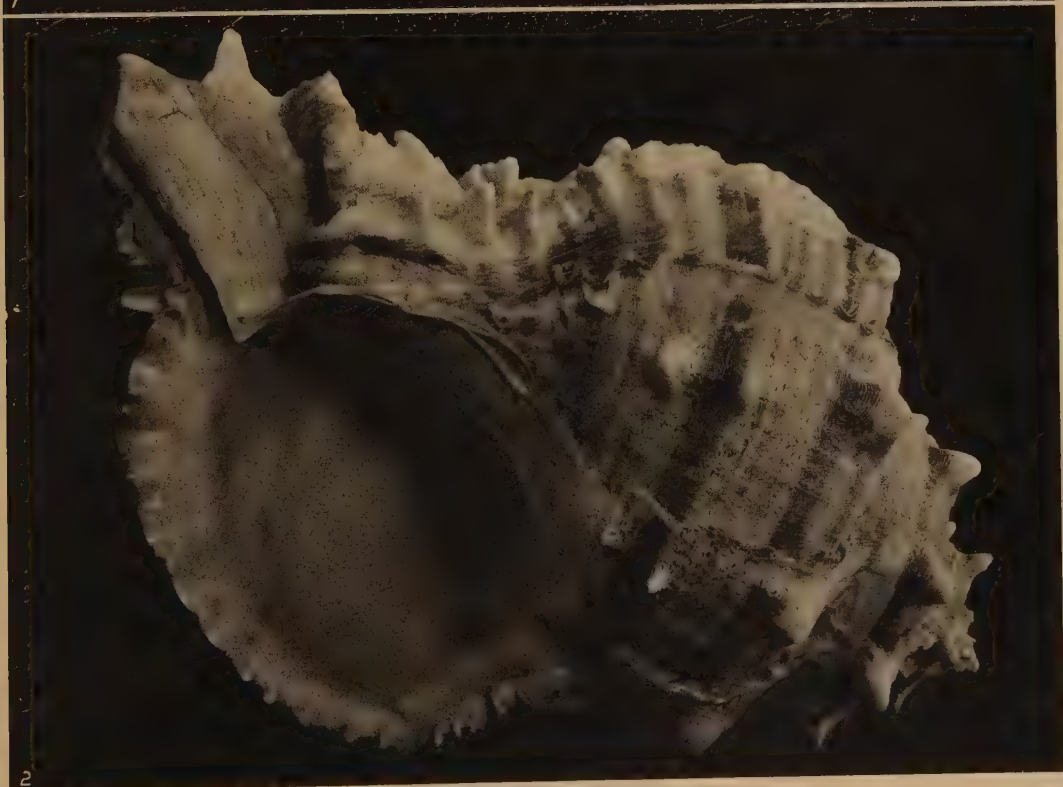
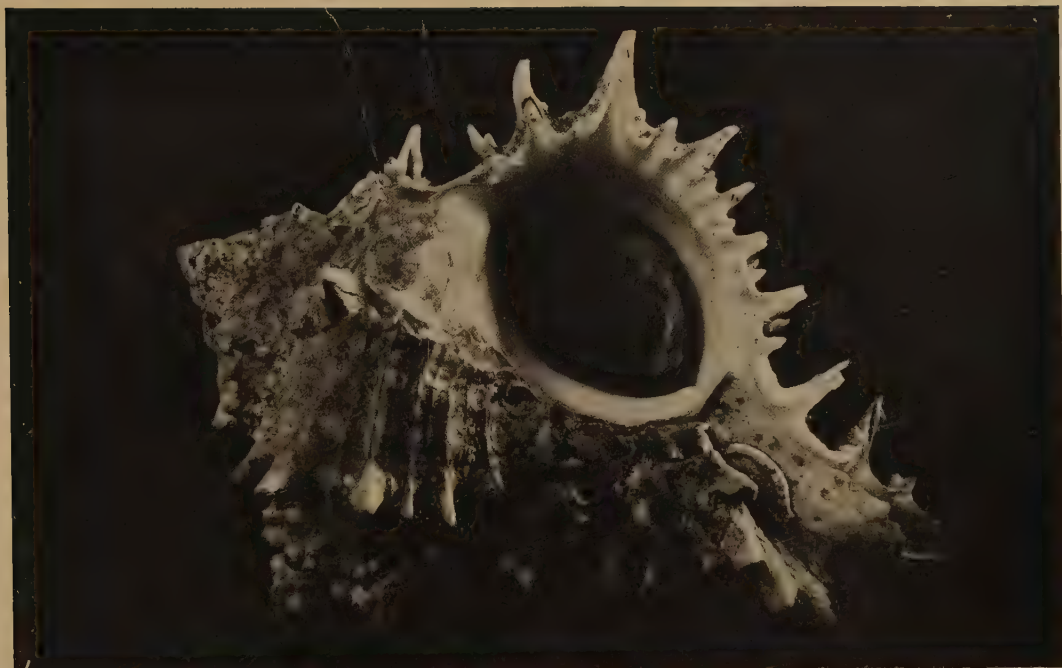
A small genus of twenty recent species differing from *Ocenebra* in its lack of varices, open canal and smoother shell; resembling *Trochus* in its dentition and *Purpura* in its operculum. It seems to Tryon a connecting link between *Murex* and *Fusus*. Distribution, Atlantic coast of America, Cape Horn, Cape of Good Hope, New Zealand, California.

The **Oyster Drill** (*U. cinerea*, Say) is a small unobtrusive looking citizen of rocky shores; his modest yellowish gray shell attracts little attention. The solid spire bears strong varicose folds across the whorls; the largest specimen is scarcely an inch long; the stronghold is closed by a horny door. You may find the rocks and drift-wood fragments alive with these mollusks at low tide almost anywhere from Maine to Florida.

This is the "oyster drill," the despair of oystermen, who place it first among the destructive agencies against which the oyster industry has to fight constantly for its life.

The animal has an extremely small foot, with a yellowish border and dotted with gray above. The small head protrudes just far enough to show its black eyes. The siphon reaches scarcely beyond the tip of the canal.

The drill has an insatiable hunger and thirst for oyster pulp, and untiring industry in appeasing its appetite. It moves sluggishly among the helpless bivalves, chooses a victim, and with its strong toothed radula soon bores a neat round hole through one valve near the hinge. It is the method used by all carniv-



MUREX SHELLS

1 Spine-ribbed Murex, *Murex spino-costata*

2 Cabbage Murex, *Murex brassica*



1 *Murex trialatus*.

MUREX SHELLS

2 *Murex festivus*.

3, 4 *Murex foliatus*

orous "snails." Through this hole the soft parts are sucked; the solid flesh may be picked at leisure from between the gaping valves.

At intervals the oysterman drags his "tangle," a great mop made of untwisted rope-fibre, and his dredge over the oyster beds, and destroys all the drills caught up by them. These are not effectual exterminators by any means; but they are the best things yet devised to combat the enemy. The creature's small size, its rapid multiplication and its ravages when present in numbers make continuous warfare upon it the only salvation for the oyster beds.

Chesapeake Bay was probably the original home of the drill. From this locality it has migrated north and south; transplanted with the oysters to San Francisco Bay, it has spread also on the west coast.

Each female lays during a period of several weeks a total of ten to one hundred egg cases. Each one is vase-shaped, vertically flattened and keeled, of clear, parchment-like membrane, containing about a dozen eggs. The cases are attached by broad foot-like bases in regular rows, forming patches on the under sides of overhanging rocks, or other support, just above low water mark.

The **Florida Drill** (*U. Floridana*, Conr.) differs from the Atlantic species in having shouldered whorls, the ribs forming knob-like projections at the angles. The ashy surface is not banded. Aperture, purplish. Length, $1\frac{1}{4}$ inches.

The **Mexican Drill** (*U. Mexicana*, Rve.) has its nodulous sculpture yellowish on a chocolate ground. It is less than an inch long, and resembles *U. Floridana*.

THE EUPLEURAS

Genus EUPLEURA, H. and A. Ads.

Shell ranelliform, with two prominent, and intermediate smaller varices; aperture toothed within. Five species. Distribution, West Indies, Atlantic coast of United States and Panama.

This confusing genus has the shell of a *Urosalpinx*, the teeth of a *Murex*, the varices of a *Ranella*, and the operculum of a *Purpura*. Tryon considers it intermediate between *Murex* and *Ranella*.

E. caudata, Say, is the type. The shell is white to dark brown, reddish brown within. There are five whorls, each shoul-

The Oyster Drill

dered, forming a steep spire, with nine stout vertical ribs, crossed by fine, close spiral lines. Usually there are two prominent varices, opposite each other. These are sometimes reduced to small size. The lip is thick and set within a border of raised granules. The animal is white except the yellow foot. Length, $\frac{1}{2}$ to $1\frac{1}{2}$ inches. Distribution, Massachusetts Bay to Georgia.

E. Tampaensis, Conr., is more robust, with sharper ribs and shorter canal. Varices scarcely distinguishable. Length, 1 inch.

Habitat. — West Coast of Florida.

THE SMOKE SHELLS

Genus **TYPHIS**, Montf.

Shell ovate or oblong, with projecting hollow tubes between the three spinose varices; aperture roundish, prolonged into closed siphonal canal; operculum as in *Murex*. Species: fifteen recent, eight fossil. Distribution, warm seas, Tropical America, Cape of Good Hope, Indian Ocean, Pacific Islands, China, Australia.

The **Large Smoke Shell** (*T. grandis*, A. Ads.) is a representative species of this small genus. The ascending tube contains an extension of the mantle margin. The varices are broad, fluted, fin-like, forming a wing on either side of the basal canal. The whorls are angled, the tubes short. Length, $1\frac{1}{2}$ inches.

Habitat. — Gulf of California.

The **Four-winged Smoke Shell** (*T. tetrapterus*, Bronn) is distinguished by the four fin-like expansions on the canal, which broaden into wing-like varices below the upcurving hollow tubes that adorn the spire. Length, 1 inch.

Habitat. — Mediterranean Sea.

The **Long-horned Smoke Shell** (*T. longicornis*, Dall) has a very long, straight anterior canal, a steep spire set with many upturned tubes, and two or more pointing downward on the body whorl. Length, $\frac{1}{2}$ to 1 inch. Gulf of Mexico.

THE TROPHONS

Genus **TROPHON**, Montf.

Shell fusiform, thin, white, with numerous sharp lamelliform varices; spaces between them, smooth or spirally ribbed; spire elevated; canal open, turned to left; aperture oval, smooth, often

dark-coloured. This genus is distributed chiefly in cold waters. One group is Arctic, another Antarctic. Species, forty.

T. clathratus, Linn., is a variable species, distributed from the Arctic Seas to Vancouver's Island, Massachusetts, Iceland, Great Britain and Norway. British forms are small, $\frac{1}{2}$ inch long, with about twenty ridges on the body whorl. The American forms are larger in many regions, and they vary in number of ribs. Doubtless they are varieties of the same species. The Icelanders call this mollusk "St. Peter's Snail."

T. muriciformis, Dall, found on the Alaskan coast, is almost exactly a miniature *Fulgur canaliculatus* in shape. It is over two inches long. It is closely related to the preceding species.

The **Three-cornered Trophon** (*T. triangulatus*, Cpr.) is large but very thin, and light of weight. Its outline is triangular; the tapering stem slopes downward from the extremities of the spreading wings of the body whorl. These are numerous and so high as to overtop the elevated spire. The colour is a soft "Quaker drab," or reddish brown; the small, round aperture is lined with white. Though an occasional specimen is washed ashore near San Pedro or at Santa Catalina Island, it is so broken as to be almost valueless. The perfect ones are dredged in deep water. Their exquisite form and colouring repay the hard work it costs to get them. They are among the rare and lovely treasures of the deep. Length, 4 to 5 inches. Southern California.

Belcher's Trophon (*T. Belcheri*, Hds.) is known among California collectors as *Chorus Belcheri*, Hds. It is broadly pear-shaped, four to six inches in length, its base a short, open canal. The colourless surface is dull and tinged with brown. The spire is elevated, the whorls distinctly angled at the shoulder, and contracted to deep sutures between. Crossing the whorls are many laminated varices. The lip is thin, and drawn out into a fold at the outer, widest part. This, closing into a hollow tube as growth proceeds, forms a coronal of curved horns around the spire. There is a large tooth on the lower margin of the outer lip. The columella is narrow and rolled back above a deep umbilicus. Shells of this mollusk are picked up occasionally at low tide from San Diego to San Pedro. It is also found in Japan. Its place among the genera of Muricidæ is uncertain; it has the operculum of *Purpura*, the tooth of *Monocerus*, the varices and canal of *Trophon*. Its dentition is like that of the *Buccinidæ*.

CHAPTER IV: THE PURPLES. DOG WINKLES

FAMILY MURICIDÆ

Sub-family PURPURINÆ

SHELL bears nodules but no varices; columella flattened, spread out; canal short, or a mere notch; operculum oblong, with lateral nucleus. A large sub-family whose boundaries cannot be definitely set at present.

Genus PURPURA, Brug.

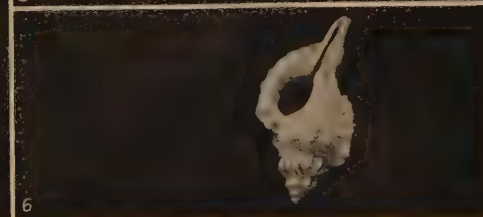
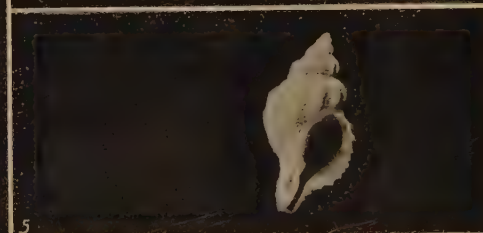
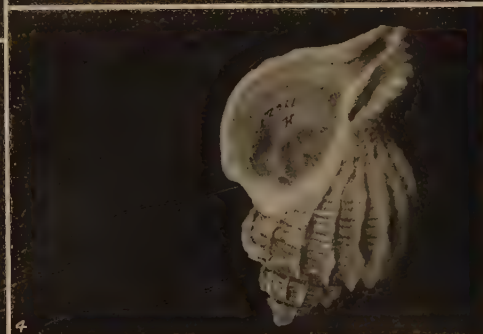
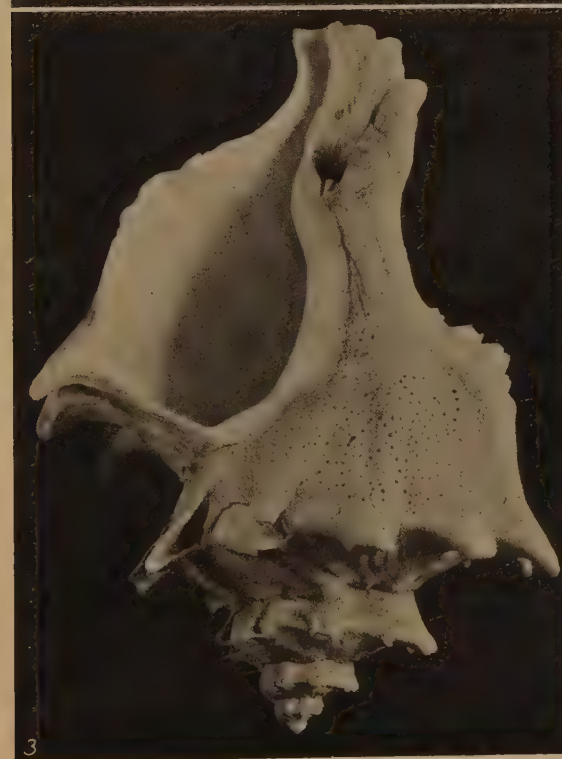
Shell oblong-oval, last whorl large; spire short; aperture large, ovate, ending in short, oblique canal or notch; columella flattened; outer lip simple; operculum horny.

A carnivorous genus, living from the water line to twenty-five fathoms' depth in all parts of the world. Recent species, fifty-seven; fossil species, forty, Tertiary.

By the recession of the tide these mollusks are left out of water twice a day for several hours. They breathe air which passes over a small quantity of water retained in the branchial cavity. They are amphibious, as well as carnivorous; and well protected by their strong shells against injury by the waves and by predatory birds and mollusks. Altogether, they are adapted to succeed in the race for life.

The common name of this genus has a long and interesting pedigree, which takes us far back into ancient history. The "Tyrian purple," famous because used solely for dyeing garments to be worn by emperors and kings, was obtained by crushing these mollusks in mortars or in pot holes along the rocky coasts of Tyre and other Mediterranean ports. Pliny says that 111 Purpuræ to 200 Buccina, pounded together, produced the richest shade of purple. The animals of large species were removed from their shells.

The colouring matter is not contained in the shell, but in a



TROPHONS, DRILL AND EUPLEURA

- 1 *Trophon triangulatus*.
2 *Trophon triangulatus*.

- 3 *Trophon Belcheri*.
4 *Trophon clathralus*.

- 5 *Urosalpinx cinerea*.
6 *Eupleura caudata*.



PURPLES AND 'NEAR RELATIVES

- | | | |
|--|--|---|
| 1 Wrinkled Purple, <i>Purpura crispata</i> . | 3 Pebble Purple, <i>Purpura lapillus</i> . | 5, 6 Castor-bean Shell, <i>Ricimula horrida</i> . |
| 2 Red-mouthed Purple, <i>Purpura hamostoma</i> . | 4 Rock Purple, <i>Purpura saxicola</i> . | 7 Hare's Ear, <i>Concholepas Peruviana</i> . |

vein or sac on the back of the body. Its use to its owner is the same as the ink of the common squid. A jet of ink colours the water, and enables the pursued to escape from an enemy. We can understand how hard and tedious was the process of obtaining this dye in quantities.

The complex art of blending the juices to produce the desired play of colouring was known only in ancient Tyre, and this secret was lost when the city was destroyed. Meanwhile the cochineal bug and modern coal tar dyes have supplied cheaper materials.

"In the reign of Augustus one pound of wool dyed with Tyrian purple sold for about £36 sterling." Six pounds of liquor were required to one pound of wool. Consequently fabrics when dyed often cost their weight in gold.

The **Princely Purple** (*P. Persica*, Linn.) is the type of this genus. It is oval, with a short spire; its brown surface is regularly spirally grooved, and wound with a narrow band of white, dotted with brown. A row of nodules encircles the upper whorls. Columella reddish yellow; aperture wide, pinkish or bluish within; lip thin, with five interrupted brown lines crossing the inner margin. Length, 3 to 5 inches.

Habitat. — Philippines.

The **Open-mouthed Purple** (*P. patula*, Linn.) is like the preceding in size, colour scheme, wide columella and gaping aperture. The spire is depressed, however, and the spiral ridges are much stronger, and irregularly tubercled. The lip is fluted, and marked with the dark brown that alternates with white on the outer surface. The columella is reddish chestnut, with a dark brown semi-lunar patch at the top. The sculpture is much sharper in young than in adult specimens.

Habitat. — Gulf of California, Philippines, West Indies.

The **Chocolate Purple** (*P. chokolatum*, Duclos), with deep chocolate exterior, knobbed along the square shoulders, and closely ridged on the thick lip, is described as a very active mollusk. The early Peruvians must have used the mollusk as food, judging by the piles of shells found near the tombs at Arica. Length, $3\frac{1}{2}$ inches.

Habitat. — Peru.

Another large species which Reeve calls *P. gigantea*, is connected by intermediate forms with *P. consul*, Lam. Spire is sharp; whorls encircled with fine brown lines; shoulders square, tuber-

The Purples. Dog Winkles

culated; columella broad, flat, orange-red; aperture orange; lip margin ridged. Length $2\frac{1}{2}$ to 5 inches.

Habitat. — Philippines.

The large species were commercially important in the earliest times because they yielded more of the precious dye than the smaller kinds.

The **Rock Purple** or **Dog Winkle** (*P. lapillus*, Linn.) is one of the best known inhabitants of northern rocky coasts on both sides of the Atlantic. *P. saxicola*, Val., of the west coast, is probably the same. This species has attained its remarkable geographical range by variations which adapt it to changed conditions of life.

The collection of *P. lapillus* made by Cooke in Great Britain alone exhibits nineteen distinct forms. Large size, prolonged spire and small mouth characterise those found on protected coasts where food is plenty and attachment to the rocks an easy matter. A low spire, a large mouth, small size and a thick shell belong to forms taken in exposed situations where food is scarce. The most strikingly banded and brightly coloured shells are found on veined and coloured rocks, the dullest in estuaries and sheltered bays.

Linnaeus called this species by a name which means "pebble": doubtless he saw, as they lay exposed by low tide, the resemblance of these numerous shells to the pebbles on the beach, and saw in that resemblance a reason for the success of the species in the struggle for existence. They share with pebbles the hard knocks all shore-dwelling mollusks get when the sea is rough. The American forms are rarely over an inch long. In England they range upward to two inches, and over, in favourable situations.

The colouring varies from whitish through all the yellows and browns, bright and dingy, to dark red. The surface may be smooth or finely cancellated or beset with tubercles. The roughest specimens in Dr. Cooke's series came from the oyster beds, six fathoms deep.

The activities of this purple are well known. He shambles about clumsily, or sits faithfully plying his drill. He is cordially hated by fellow pensioners on the bounty of the sea. He eats oysters and mussels, thrusting the long proboscis into the hole laboriously drilled through one of the valves, and sucking out the contents. *Mytilis edulis*, the edible mussel, is his favourite food. Lacking this delicacy, he will bore the shells of limpets and barnacles — even pick the bones of dead fish and crabs.

He is almost always eating, or in quest of food; if at rest on a rock you may believe he is digesting a full meal.

The starfish, also a lover of oysters, sometimes falls upon his molluscan rival. By stealth he gathers several purples in his five fingers, laying hold of them with the delicate suckers, and bringing them to the central mouth. The stomach turned wrong side out envelops the purples which are dissolved out of their shells by the strong digestive fluids the stomach walls secrete. Hermit crabs, secure in borrowed tenements, sometimes attack and destroy a colony of purples by a concerted attack.

The egg capsules of this species are like delicate pink grains of rice set on tiny stalks. They are found in groups on protected rock surfaces. "A single individual has been observed to produce 245 capsules." — *Cooke*. Each contains twenty to forty embryos. The active period of breeding is from January to April, on English coasts, but egg-laying goes on all the year round. The capsules are called "sea cups."

"Horse Winkle" is the Irish name for this purple. "Dog Winkle" and "Sting Winkle" are English nicknames.

The original home of this species may have been northern Europe. Here it attains its maximum size. It migrated to America by way of Iceland and Newfoundland, no doubt, and down the Atlantic coast to Florida. Our forms are smaller and duller than the European.

The operculum of *P. lapillus* and other small univalves is the "eye stone," kept by druggists. A cinder in the eye, or particles of dust, adhere to the surface of the eye stone as the muscles move it about under the eyelid. Similarly, a flax seed removes irritating particles.

Thrown in a dish of water with a dash of muriatic acid these little calcareous bodies move about as if alive. The energy they exhibit is chemical, of course, but ignorant people "tell fortunes" by the aid of these animated objects.

The **Florida Purple** (*P. floridana*, Conr.) has an elevated spire of angled whorls with fine nodules around the shoulders, it is spirally grooved and banded with yellow and black and longitudinally cross-banded with black. Lip and columella are orange; aperture paler, often banded. Canal somewhat long. Length, $1\frac{1}{2}$ to 2 inches.

Habitat. — North Carolina to Florida.

The Purples. Dog Winkles

The **Rock Purple** (*P. saxicola*, Val.) is as abundant on the California coast as its near relative, *P. lapillus*, is on the coast of New England. It exhibits as great a tendency to vary. The shell is thicker, with a smaller aperture. Specimens reach one and a half inches in length, but the average specimen is less than an inch long. The dingy exterior is marked with double spiral bands of brown. The lip is sharp; the columella twisted and flattened; the spire short.

Habitat.—California.

The **Grooved Purple** (*P. lima*, Mart.) lives in deeper water, so is more rare than the last species. It has an elevated spire of four rounded whorls separated by deep sutures. Fifteen spiral grooves sculpture the surface uniformly. Colour, light brown. Length, $\frac{1}{4}$ to 1 inch.

Habitat.—California.

The **Wrinkled Purple** (*P. crispata*, Chemn.) ranges northward from San Francisco Bay to Alaska. The species improves as it moves to higher latitudes. Specimens from Puget Sound are two inches long, with longitudinal frills and spirally banded with rich brown. Smoother specimens, of duller hue and smaller size occur southward. The white aperture is smaller; the lip is toothed within.

THE CASTOR BEAN SHELLS

Genus **RICINULA**, Lam.

Shell ovate, solid, usually with spiny processes on the numerous varices; aperture long, narrow, toothed; canal short, oblique; columella wrinkled; operculum horny, thin, semi-lunar. Includes thirty species, inhabiting coral reefs among Polynesian Islands.

This genus, much like *Purpura*, contains also a sub-genus named "mulberry shells." The compact shape and spiny or lumpy surface give reasonableness to the common name.

The **Bristly Castor Bean Shell** (*R. horrida*, Lam.) is studded with stout black tubercles on a white ground. The flaring outer lip and the exceptionally wide columella are tinged with violet. The lip bears strong inner teeth; the columella, cross folds below the middle. Length, 1 to $1\frac{3}{4}$ inches.

Habitat.—Hawaiian Islands, Philippine Islands.

The **Fingered Castor Bean Shell** (*R. digitata*, Lam.) has long finger-like processes on the lip. Its spiny exterior is colourless; the aperture, orange-red. Length, $1\frac{1}{2}$ inches.

Habitat.—Central Pacific Islands.

The largest species is *R. bystrix*, Linn., a ponderous shell, with flattened spire and broad shoulder, tawny brown, set with stout, short fingers. The aperture is small and round; the flaring lip and columella are rose-coloured. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.—Central Pacific Islands.

The **Mulberry Shell** (*R. morus*, Lam.) is well named. Its white spire is covered with rounded black (rarely white) nodules. The aperture is violet. Length, $\frac{3}{4}$ to 1 inch.

Habitat.—Polynesia.

THE UNICORN SHELLS

Genus MONOCEROS, Lam.

Distinguished from *Purpura* by the distinct tooth or horn developed on the outer lip near the canal. A small genus almost exclusively confined to the west coast of America.

The **Angled Unicorn** (*M. engonatum*, Conr.) lives among seaweeds on rocks swept by the tides. Its whorls are square shouldered, set apart by a deep winding suture, and forming a prolonged spire. The whorls bear fine spiral striations, crossed by wavy lines of growth. The lip is toothed, the horn is sharp and long. The shells are like the rocks in colour; especially when wet. Length, $1\frac{1}{2}$ inches.

Habitat.—West coast of United States.

The **Pebbly Unicorn** (*M. lapilloides*, Conr.) is a solid little shell, plump in form, and marked so that it resembles a granite pebble. The small aperture has a row of knobs above the horn. Length, 1 inch.

Habitat.—West coast United States.

The **Sad Unicorn** (*M. lugubre*, Sby.) reaches Southern California beaches from its native Mexican coast. It is dull and heavy, the aperture even, a dark brown. The lip bears white knobs of small size. Length, 1 inch.

The **Giant Unicorn** (*M. giganteum*, Less.), yellow, fusiform,

The Purples. Dog Winkles

with revolving lines of brown on the smooth whorls, and the tell-tale basal tooth on the lip, is the largest of the genus. Length 3 to 5 inches.

Habitat.—Chili.

THE HARE'S EAR

Genus CONCHOLEPAS, Lam.

Shell heavy, ovate, last whorl disproportionately expanded; spire short, turned obliquely to left, aperture wide, with slight channel at anterior margin; inner lip flattened; outer, with two small teeth; operculum small, inadequate; exterior of shell strongly ribbed and set with lamellate scales. Foot large, occupying the whole aperture.

Concholepas Peruvianum, Linn., looks like a great limpet or *Haliotis*, clinging to rocks on the Peruvian coast by the suction of its broad foot. The Chilians pound the rubbery flesh until it is tender, then cook it and esteem it an excellent sea food. Down the west coast the tribes use the shells for drinking cups, as they are of handy size and shape.

Genus MAGILUS, Montf.

Shell spiral when young, thin, few-whorled, with wide mouth; operculum ovate; later the shell is extended into a long, keeled tube. Animal highly organised.

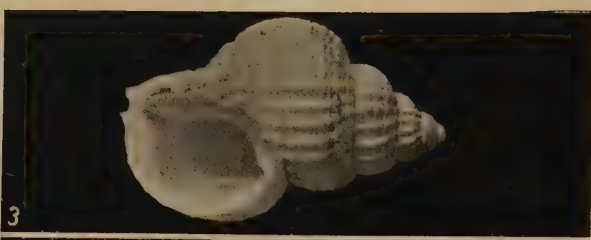
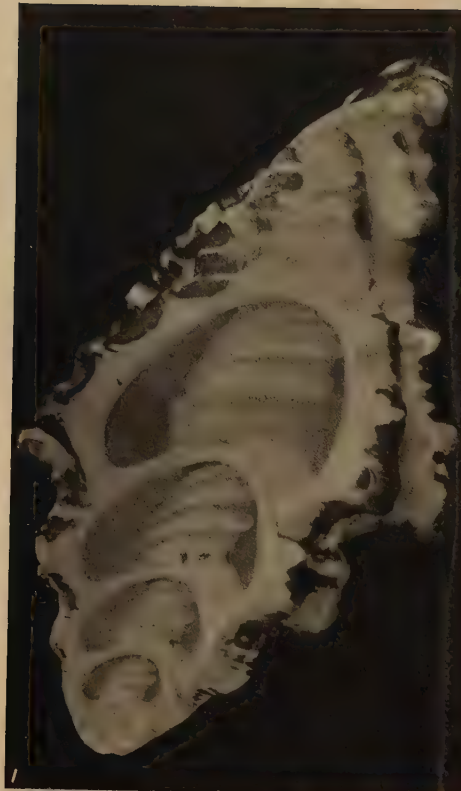
M. Antiquus, Linn., begins life with a pretty, smooth shell, like that of a whelk. Soon it attaches itself to a coral. As the polyps grow, adding thickness to the solid wall, the mollusk extends its aperture, and keeps it flush with the surface. The animal, too, keeps moving outward, closing up the shell behind it with solid lime.

Habitat.—Red Sea, Indian Ocean.



UNICORN SHELLS AND MAGILUS

- | | |
|---|---|
| 1 Giant Unicorn. <i>Monoceros giganteum</i> . | 4 <i>Monoceros angulatum</i> . |
| 2 <i>Monoceros engonatum</i> . | 5 <i>Magilus antiquus</i> , showing spiral beginning, |
| 3 <i>Monoceros lugubre</i> . | and its later habit of living in coral. |



TRITONS

1 *Vasum ceramicum*

2 *Triton lotorium*

3 *Triton scaber*

4 *Triton tritonis*

CHAPTER V: THE TRITONS AND FROG SHELLS

FAMILY TRITONIDÆ

SHELL spiral, thick, with one or two varices to each whorl; aperture round, with thick lips, and anterior canal; operculum present; mantle enclosed; foot small, siphon short; lingual ribbon set with seven rows of teeth; eyes on tentacles.

A large tropical family of three genera allied to Muricidæ on one side, and Doliidæ on the other. They subsist upon decaying animal matter and live from low water to fifty fathoms depth.

Genus TRITON, Montf.

Shell ovate or oblong, with prominent elevated spire, ribbed and crossed by varices, usually few, remote, and non-continuous; columella smooth, wrinkled or noded; outer lip thick, and scalloped or toothed within; canal long or short, turned up; operculum horny, ovate or annular, with nucleus marginal.

A handsome tropical genus of about 150 species, including one that reaches 18 inches in length—"almost the largest of gastropod mollusks," writes Tryon. Some species have world-wide distribution, accounted for by the fact that the young are pelagic and free-swimming, very different creatures from the staid adult Tritons. The metamorphosis occurs some time after hatching.

"The Tritons are shells of much more solid structure than the Murices or Ranellæ, and of much more simple growth. They are not furnished with any spines nor have they any ramified branches like the Murices; the rude manner in which the whorls are convoluted seems rather to indicate that their animal inhabitant, though possessing abundant power of calcification, is of somewhat sluggish growth."—Reeve.

A very tough skin covered with hairs or bristles protects the shell externally in most species. The lip curls in as the mollusk matures, forming a marginal channel which is filled with

shelly material. This thickening of the lip precedes a period of rest. When growth is resumed the mantle extends the shell leaving the thickened lip behind as a varix crossing the whorl.

The apex is peculiar in structure. It is horny with a thin plating of shelly substance outside. The shell is often seen chipped off, exposing the horny foundation.

Triton's Trumpet (*T. tritonis*, Linn., *T. variegatus*, Lam.) is called "the Variegated Triton," by Reeve. Variegated it is, with buff, and brown, purple and red, in rich patterns suggesting the plumage of pheasants. The ground is pale; the dark colours are laid on in crescentic patches, no longer than the width of the spiral ridge they ornament. The columella is dark purplish brown, crossed by white wrinkles. The spire bears about a dozen flat varices. The outer lip is toothed, and whitish, with double streaks of brown soon fading into the ruddy aperture. The canal is short and recurved.

This is the giant Triton which reaches sixteen or eighteen inches in length. The Pacific Islanders use it for a teakettle, the operculum being the lid and the canal, the spout. The shell is hung by a wooden hook over the fire. The long spire and swollen body whorl give a sixteen-inch Triton considerable capacity.

Habitat.—New Zealand, Polynesia, Philippines, Japan, Indian Ocean.

Variety *nobilis*, Conr., differs from the type in being broader and heavier, with a distinct shoulder, especially noticeable on the body whorl. The first few coils of the spire are quite smooth. The aperture is pale orange. The shoulder appears only on adult shells. This is the West Indian Triton, found also in the Mediterranean and Cape Verde Islands.

The **Knobbed Triton** (*T. nodiferus*, Lam.) is a big-mouthed, stout trumpet shell, with a double row of knobs encircling its spire. Instead of becoming larger on the body whorl, the knobs fade out. There are Tritons much more noticeably knobbed than this one. The gaping throat has a pale lining. Brownish yellow tessellations adorn the strongly ridged exterior and mark the toothed lip border. The broad, brown columella is wrinkled above and below. Length, 5 to 10 inches.

The species in somewhat variable forms occurs up the Atlantic Coast of Europe to the British Channel, and South to the Canary

Islands. In the East, it is found in Japan, Australia and New Zealand, and in Natal and Mauritius in Southern Africa. Tryon considers *T. Sauliæ*, Rve., and *T. australis*, Lam., variations of this species.

"Madame Power found this animal capable of reproducing amputated tentacles. The Sicilians and Algerians eat the mollusk, and esteem it a delicacy. At Nice, the fishermen and country people make a hole in the apex of the spire and use the shell as a trumpet, which produces a braying sound. It is an indispensable instrument in the old-fashioned charivari, which she describes as a deafening serenade to signalise the marriages of ill-assorted or unpopular couples."—*Tryon*.

The **Oil-vessel Triton** (*T. olearium*, Linn.) has a thick, broad shell, with few varices and a blunt spire, strongly ribbed and set with tubercles, more or less prominent. The ground colour is light brown, spotted alternately with dark brown and white. The aperture is flesh-coloured, the columella dark brown with raised white wrinkles.

The Greek lamp is not unlike this shell in form. The skin is thin, and is marked by hairy tufted ridges in life. The animal is pale yellow, with black spots which are more remote and larger on the head; the tentacles are long and black. Length, 2 to 6 inches.

Habitat.—Mediterranean, Atlantic coast of Europe and Africa; West Indies to Brazil; Australia to Japan.

The **Hairy Triton** (*T. pilearis*, Linn.) is recognised by its bristly coat of olive-hued epidermis, its fusiform shape and its red mouth crossed with long white raised ridges. The pale brown exterior is streaked with revolving bands and folds of white. Length, 2 to 6 inches.

Habitat.—Philippines, New Zealand.

The **Thigh-arm Triton** (*T. femorale*, Linn.) has a triangular outline, and each whorl has a shoulder so distinctly angled as to stand out like a blade. The spiral ridges are rounded, separated by broad depressions which are also ridged. The ridges are dark brown, the lower areas reddish brown. This shell has a contracted base, which includes the straight canal, which is one-fourth the total length of the shell. The varices are prominent rounded folds of the ribbed surface. The rounded knobs are bright yellow. There is a thin bristly epidermis. "The varices originally served as models for the gadroon border used by

silversmiths in the decoration of plate."—*Reeve*. Lip and columella are smooth.

This West Indian species is 3 to 7 inches long.

The **Tiger Triton** (*T. tigrinus*, Brod.) 5 to 7 inches long, has the tiger's tawny colouring on its horny, tufted exterior. The lip flares when full grown in to a wide, wavy margin. The aperture is orange.

Habitat.— West coast Central America.

The **Club Triton** (*T. clavator*, Lam.) is typical of a group of trumpet shells of pear shape, with long, narrow, twisted canal, and two shiny porcellaneous lips, the inner one reflected over the columella. The revolving ridges bear tufted hairy fringes in life. The narrowed aperture has a bright red lining. The exterior is whitish, the rounded varices marked with brown. Length, 2 to 5 inches.

Habitat.— Philippine Islands.

The **Pear Triton** (*T. pyrum*, Lam.) is a bright orange shell, lined with paler colour. The teeth of the lip are very strong and white. The columella bears narrow white folds. The long narrow base is curved. The exterior is strongly ridged and knobbed with prominent varices. The apex is blunt. Length, 3 to 4 inches.

Habitat.— Philippine Islands, Indian Ocean, Madagascar.

The **Canaliculated Triton** (*T. caudatus*, Gmel.) is distinguished from the species above by the deep canal that runs around the top of each whorl. It is a white shell, with double spiral ridges, and a long, slim, twisted canal. Length, 3 inches.

Habitat.— Chinese Seas.

The **Chinese Triton** (*T. Sinensis*, Rve.) has the size, form and colouring, but lacks the canal that sets it and *T. caudatus* apart.

The **Quilted Triton** (*T. tuberosus*, Lam.) has oblong swellings all over its surface, and the mouth is stained with dark red. The six rounded varices are prominent and light coloured. The ground is ashy or dark brown. The noded teeth are whitish. The columella is smooth, yellowish, and thickly enamelled. The canal is long and slightly curved. This commonest of the trumpet shells exhibits considerable variation in colouring and other characters. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.— West Indies, Indo-Pacific Ocean, Polynesia, Mauritius.

The **Spotted Triton** (*T. maculosus*, Gmel.) is typical of a sub-genus in which the aperture is small, the canal short, and the spire long and gently curved. The surface is latticed with crossing ridges of small size. The body whorl is swollen, with a wide inner lip reflected over the smooth columella. The pale ground is spotted with brown. The thick shell is three inches long.

Habitat.—Mauritius, Red Sea, Philippines.

T. truncatus Hds. and **T. decollatus** Sby., in this sub-genus are good illustrations of decollation. The spire is elongated and destitute of varices. The apex is gone, as if cut off square by some sharp tool. Each is a Philippine species under an inch long. The shells in this group run into minute sizes.

Sub-genus Priene contains large, thin, white shells, with cancellated surfaces and swollen body whorls. They are usually lacking in varices. They are connecting links between the Tritons and related genera.

The **Furred Triton** (*T. scaber*, King) has close, thick, persistently bristly epidermis, a low, broad spire, and wide mouth. The shell is white and finely cross-ridged. The lip is toothed within. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.—Arctic America to California.

The **Cancellated Triton** (*T. cancellatus*, Lam.) is a handsome fusiform shell, finely or coarsely sculptured by the intersection of many transverse and revolving ridges. Rounded nodules often mark these crossings, and these bear tufts of hair, sometimes half an inch long. Length, 3 to $4\frac{1}{2}$ inches.

Habitat.—Japan. Alaska to Straits of Magellan.

The **Oregon Triton** (*T. Oregonensis*), described by Redfield from a half-grown specimen, is considered by Tryon identical with the preceding species. It is common on the Northwest coasts, a handsome fusiform shell, with shaggy brown skin, deeply latticed surface, and smooth, white lining. Length, 4 to 6 inches.

THE WARPED SHELLS

Genus **DISTORSIO**, Bolt.

This genus differs from Triton in its distorted spire, and its irregular, contracted, thin, flaring aperture. It has three species

distributed widely in warm seas. *D. cancellinus*, Roissy, is the type.

D. anus, Linn., has a very small aperture, from which the enameled lips flare into a white ruffled border, almost as wide as the body of the shell. There is scarcely any canal. The surface is cancellated, with brown bands on a white ground. Length, 2 to 3 inches.

Habitat.—Red Sea Indian Ocean, Philippines.

THE FROG SHELLS

Genus *RANELLA*, Lam.

The Frog Shells are mostly large and heavy, with surface granulated and tuberculated. Possibly this warty appearance accounts for the name. Possibly it is the squat shape of some species, with their sprawling leg-like tubercled processes. The genus is distinguished from the Tritons by the uniform presence of a varix on each half coil of the shell. These form thick ridges on opposite sides, making the shells distinctly two-edged.

The genus of about fifty species is distributed in tropical seas. The animals are active in movements, creeping on the broad foot over coral reefs and rocks.

The **Spiny Frog Shell** (*R. spinosa*, Lam.) has two thorn-like tubercles on each of its varices, and short, sharp spines on the ridges between. The shell is stout, with short spire and canal, and ovate aperture. Colour, light brown mottled with darker. Length, 2 to 3 inches.

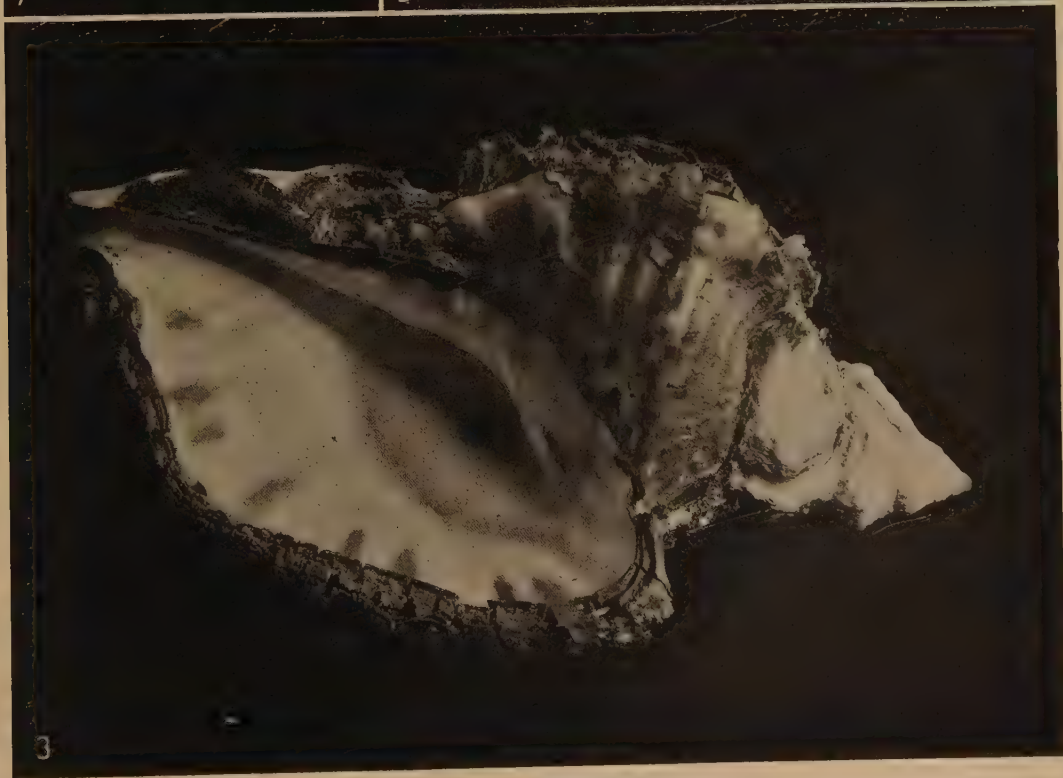
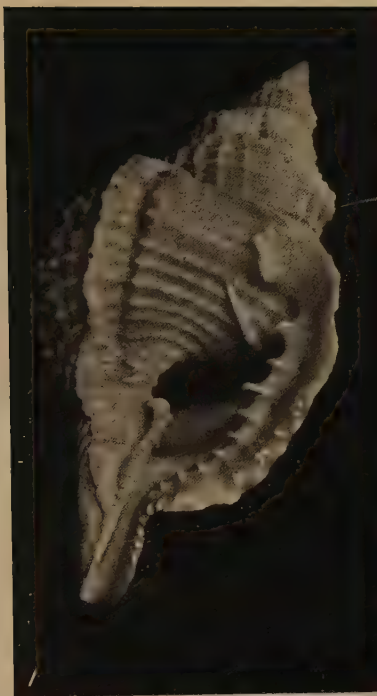
Habitat.—Mauritius, Indian Ocean, Philippines.

The **Californian Frog Shell** (*R. Californica*, Hds.) is a fine species, $2\frac{1}{2}$ to 4 inches long, with heavy, strongly ridged and tuberculated shell, turreted spire, wide aperture, with flaring lips, and short anterior and posterior channels. The colourless surface is irregularly banded with chestnut; the lining is faintly rosy.

Except for its greater thickness and stronger development of nodules, this species might be mistaken for *R. ventricosa*, Brod., a Peruvian species with an exceedingly thin shell.

Habitat.—Southern and Lower California.

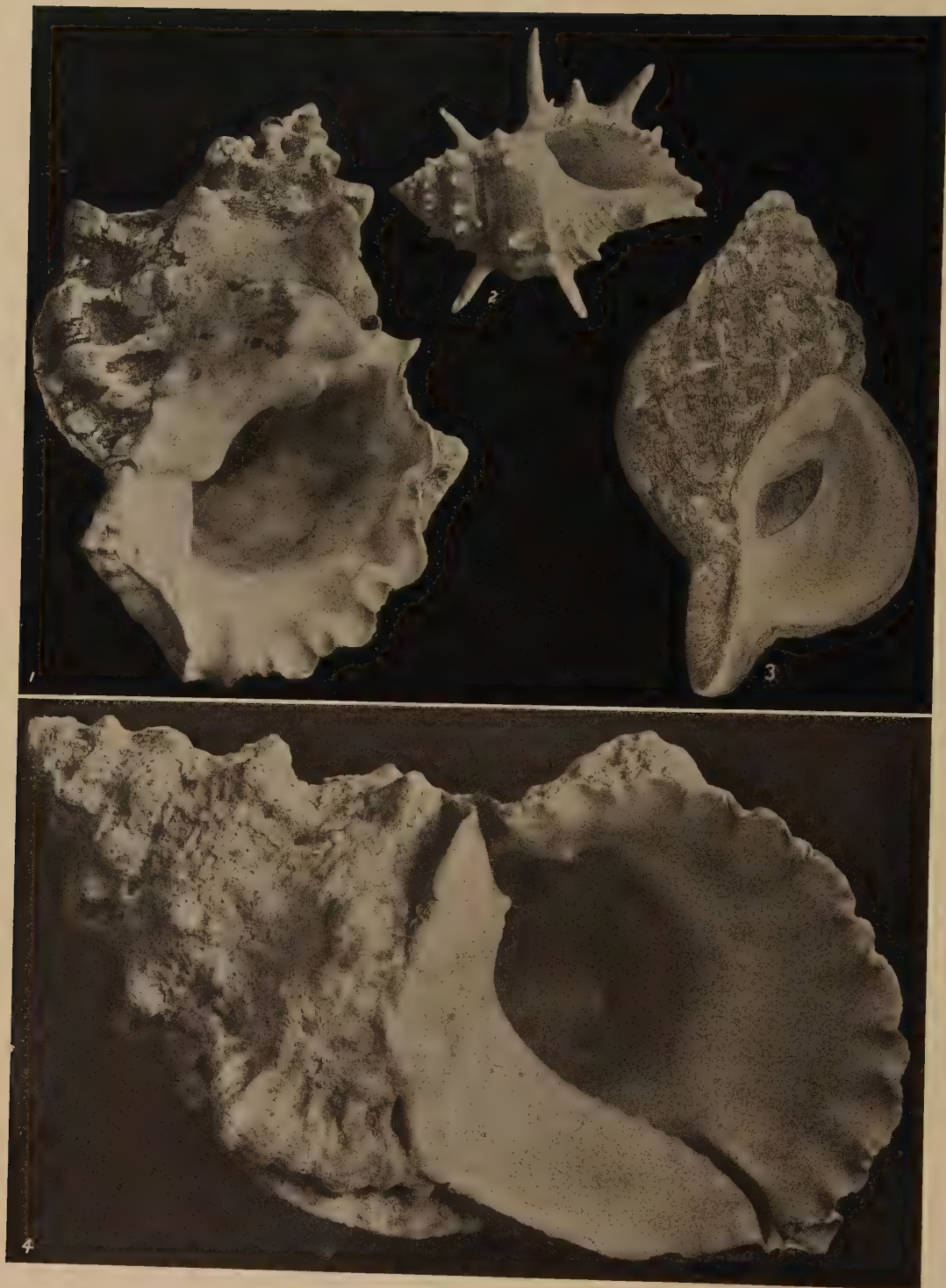
The **Lamp Ranella** (*R. lampas*, Linn.), the heaviest shell



TRUMPET SHELLS

1, 2 Warped Shell, *Distorsio cancellinus*

3 Tiger Triton, *Triton tigrinus*



FROG SHELLS AND A TRITON

- 1 California Frog Shell, *Ranella Californica*.
- 2 Spiny Frog Shell, *Ranella spinosa*.
- 3 Oregon Triton, *Triton Oregonensis*.
- 4 Lamp Frog Shell, *Ranella lampas*.

in the genus, no doubt made a useful lamp for primitive man. Its strong revolving ridges are elaborately set with nodules. The flaring lip is deeply crenulated. There is a posterior channel equal to the anterior canal. When half grown the shells are heavy and show the adult characteristics. The creamy ground colour is stained with orange brown; the aperture has a flesh tint. In young shells the colours are brighter; the lip and aperture orange-red. Length, 3 to 9 inches.

Habitat.—Red Sea, Indian Ocean, Philipppines.

The **Argus** *Ranella* (*R. Argus*, Gmel.) has an ovate, ventricose shell with nodules of moderate size evenly distributed over its surface, sometimes large and few, sometimes small and crowded. The colourless surface is spirally banded with brown. The eyed appearance is due to wearing off the brown on the nodules. The thick lip is obscurely wrinkled inside, and often bears a tooth at the edge of the anterior canal.

This species feeds by night on the skeletons of seals left by fishermen on the rocks on the Islands of Amsterdam and St. Paul (Indian Ocean). A dead bird or a fish hung as bait over night in water thirty or forty feet deep will capture them without fail. Fresh specimens are covered with a brown, wrinkled epidermis. Length, $2\frac{1}{2}$ to 4 inches.

Habitat.—Cape of Good Hope, Chili, Indian Ocean, New Zealand.

The **Beautiful** *Ranella* (*R. pulchra*, Gray) has its varices prolonged into fan-like wings or fins, sculptured by ribs and nodules. The whorls are rounded, the apex elevated, the white aperture prolonged into a considerable canal. The lip and columella are narrow and smooth. Length, $1\frac{2}{3}$ to $2\frac{1}{4}$ inches. Colour, pale yellow mottled with pale brown.

Habitat.—Japan, Philipppines.

CHAPTER VI: THE SPINDLE SHELLS AND BAND SHELLS

FAMILY FUSIDÆ

SHELL more or less spindle-shaped; varices none; lip not thickened; operculum ovate; animal as in *Murex*.

Genus *FUSUS*, Lam.

Shell spindle-shaped; spire many-whorled, sharp-pointed, longer than body whorl; colour yellow to brown, sometimes spotted, never banded; aperture oval, striate within; canal long, narrow, straight; columella smooth, arched. A large genus of world-wide distribution in warm seas. Living species, about seventy; fossil species, from Cretaceous to Eocene, about three hundred. Some of the largest and most elegant forms to be found among shells occur in this genus.

The **Nicobar Spindle Shell** (*F. Nicobaricus*, Lam.), the type of the genus, has the long, elegant spindle shape, with square-shouldered whorls, crowned with distinct nodules. The ribs below the shoulders are rounded and separated by deep fossæ and inclined to be tuberculate. The pale surface is copiously flamed with dark brown. The aperture is white. The straight canal is as long as the spire. Length, 5 to 6 inches.

Habitat.—Japan, Philippines.

The **Pagoda Spindle Shell** (*F. Pagoda*, Less.) is a small but remarkable shell. The pyramidal spire of many whorls is ornamented by a continuous spiral row of curving, short, upturned cusps or spines. The lower part of the body whorl is sharply keeled. The canal, almost twice as long as the spire, is wound with several spiral rows of short spurs. Colour, yellow to chestnut. Length, 2 to 2½ inches. Depth, 14 fathoms.

Habitat.—Corea.

The **Snout-bearing Spindle Shell** (*F. proboscidiiferus*, Lam.) is a gigantic species, resembling in shape the pear conch

of the Atlantic coast. Its whorls are grooved, and a conspicuous round knob finishes the angle of the shoulder. The apex is prolonged into a sharp peak, set with nodules. The long, open canal is slightly bent. An umbilicus is parallel to it. A silky epidermis covers the shell. Exceptional specimens reach two feet in length. Colour, yellowish brown. Length, 8 to 12 inches.

Habitat.—Australia.

The **Very Long Spindle Shell** (*F. longissimus*, Gmel.) is white when the pale horn-coloured epidermis is lost. Fine striations wind around its whorls, and ten large, low tubercles stand on the keeled shoulder of each. This is the longest of the spindle shaped species. *F. candidum*, Gmel. is the same. Length, 7 to 9 inches.

Habitat.—Ceylon.

The **Noble Spindle Shell** (*F. nobilis*, Rve.), a superb shell, quite like *F. longissimus*, was described by Reeve, from a single cabinet specimen, 10½ inches long.

The **Waved Fusus** (*F. undatus*, Gmel.) has few and large tubercles made by longitudinal waves of elevation and depression which cross the fine spiral grooves. The shell is thick and white. Length, 6 to 7 inches.

Habitat.—Polynesian Islands

The **Distaff Fusus** (*F. colus*, Linn.), tinged brown on its attenuated extremities, is as long as *F. undatus* and twice as slender. Fine nodules rim its whorls at the shoulder. Length, 6 to 7 inches.

Habitat.—Ceylon.

The **Long-tail Fusus** (*F. longicaudus*, Bory) may be a form of the last without the spiral keel on its whorls. Length, 5 to 6½ inches.

Habitat.—Ceylon.

The **Very Slender Spindle** (*F. gracillimus*, Ads. & Rve.), coloured a rich chestnut brown, the spiral ribs crossed by longitudinal folds, is like a miniature "long-tail." Length, 3 inches.

Habitat.—Eastern Seas.

The **Needle Fusus** (*F. acus*, Ads. & Rve.), the most graceful of the spindle shells, reduces slimness to its lowest terms. Two inches is its maximum length. In sculpture and colour it is like the last species. The aperture and canal are contracted.

Habitat.—China Sea.

The Spindle Shells and Band Shells

The **Morocco Fusus** (*F. Maroccanus*, Gmel.) is left-handed, but one inch long, and has a short canal, twisted to the right. Its finely ribbed whorls coil in a slanting position as if lifted by the large mouth. There seems to be doubt as to the location of this species, set down by some authority to the West Indies.

The spindles of colder waters are small and have a more ovoid shape.

The **Ashy Fusus** (*F. cinereus*, Rve., *F. luteopictus*, Dall) has a long spire and short canal. Strong folds and ribs cross to produce a latticed surface, marked with ashy blue on a white ground. The mouth has a brown lining. Length, 1 inch or less.

Habitat.—San Francisco to San Diego, Cal.

F. Kobelti, Dall, white, spirally pencilled with brown, with rounded, finely ribbed whorls crossed by sharp-edged folds, is a little known species. Length, 2 to 2½ inches.

Habitat.—Catalina Island and Monterey, Cal.

The **Scorched Fusus** (*F. ambustus*, Gld.), brownish yellow as if scorched, has eight keeled whorls, crossed by eight rounded varices and encircled by narrow, elevated ridges, separated by wide depressions. The roundish aperture is somewhat small; the columella smooth; channel short. Length, 1 to 1¾ inches.

Habitat.—Mazatlan.

THE BAND SHELLS

Genus FASCIOLARIA, Lam.

Shell spindle-shaped, with sharp spire, and long, oval aperture ending in an open, straight or twisted canal; body whorl swollen; surface spirally banded; columella smooth, with a few anterior, oblique plaits; lip crenulated within; operculum claw-shaped, filling the aperture. Animal as in *Fusus*, slow of movement, crawling on mud flats or burying all but the tip of the spire in the sand. Conspicuously large and handsome shells, distributed in shallows of all warm seas. Species, fourteen living, thirty fossil.

The **Orange Band Shell** (*F. aurantiaca*, Lam.) is buff orange mottled with white in an irregular pattern. The whorls are keeled and set with blunt nodules. Fine dark lines in pairs wind spirally from the apex. This showy species, called "the Persian



SPINDLE SHELLS AND OTHERS

1 *Vasum castum*.
2 *Bulla callosa*.

3 *Clavella serotina*.
4 Kobelt's Spindle Shell, *Fusus Kobelti*.
5 Longest Spindle Shell, *Fusus longissimus*.

6 Knobbed Spindle Shell, *Fusus undatus*.
7 Nicobar Spindle Shell, *Fusus Nicobaricus*.



MARINE UNIVALVES

- | | |
|--|---|
| 1 Distaff Spindle Shell, <i>Fusus colus</i> . | 4 Crown Melongena, <i>Melongena corona</i> . |
| 2, 3 Tulip Band Shell, <i>Fasciolaria tulipa</i> . | 5 Ten-ridged Neptunea, <i>Neptunea decemcostata</i> . |

Vest" in Lamarck's day, is known in cabinets, but its habitat is uncertain. Tryon doubtfully names Brazil and Cape of Good Hope. Length, 3 to 5 inches.

The **Tulip Band Shell** (*F. tulipa*, Linn.) is found in shallow water, on pebbly coasts where water is calm and algæ grow. A collector found several feeding upon a dead king crab. They made valiant attempts to escape, striking viciously about with their operculums.

This is one of the handsomest of our native shells, the equal of any garden tulip, in form, if not in coloration. The graceful rounded whorls taper away from the swollen centre to a sharp spire and a straight canal. The surface is smooth, closely wound with the pairs of dark hair lines that characterise the family. Wavy lines of gray cross the whorls, over these are distinct irregularly broken longitudinal bands of bright chestnut or darker brown. In fact, colour and design vary greatly. A uniform dark mahogany form is found. The thin lip is finely scalloped. The columella is narrow, with three oblique folds. The aperture has a flesh-coloured lining. Length, 4 to 8 inches.

Habitat.—North Carolina to West Indies.

Var. *distans*, Lam., has its revolving dark lines wide apart on the whorls. It is a much smaller, smoother shell, and more delicately painted, but similarly shaped and marked. It frequents the same localities. It feeds upon *Vermetus*, thrusting its long proboscis into the limy tubes of the "worm shell" and sucking out the soft parts.

The **Giant Band Shell** (*F. gigantea*, Kiener) is one of the largest known univalves. Its shell is a ponderous affair, impressive in size and weight. The surface is yellowish under a horny brown epidermis. The aperture is a uniform orange-red, showing no lines. The dark revolving lines are close outside. The keel of each whorl bears large, remote, low tubercles. This is the only adversary that comes off victorious in an encounter with *Melongenacoma corona*. Superior size and strength overcome the fighter, which is smothered. Length, 1 to 2 feet.

Habitat.—North Carolina to West Indies and Brazil.

The **Prince Band Shell** (*F. princeps*, Sby.) is a giant of the tropical west coast of America. It is very graceful in form, its keeled whorls strongly ridged and deeply grooved. The exterior is a rich brown, with a persistent epidermis. The orange-red

The Spindle Shells and Band Shells

aperture is scored with groups of raised parallel red lines, making it look like blank music paper. Length, 6 to 9 inches.

Habitat.— Panama to Mazatlan.

The **Salmon-coloured Band Shell** (*F. salmo*, Wood) has a low spire, trimmed with nodules, a wide aperture notched above, with crimped lip, a straight canal, and columella bearing two strong plaits. Exterior salmon-yellow, with thin brownish epidermis. The body is bright red. Length, 4 to 5 inches.

Habitat.— Panama to Mexico.

CHAPTER VII: THE WHELKS. TRUMPET SHELLS

FAMILY BUCCINIDÆ

SHELL usually thick, oblong to fusiform, with canal of moderate length or short; periostracum thick; columella without folds; outer lip simple, often thickened; operculum horny.

A large and aggressive family of carnivorous habits, ranging from tropical to circumpolar seas.

Genus **MELONGENA**, Schum.

Shell pear-shaped, solid, dark-coloured, or banded; spire short, set with knobs and spines; aperture oval; canal short; columella and lip smooth; operculum solid, claw-like; nucleus apical. Comprises about a dozen species in warm seas of both hemispheres.

The **Crown Melongena** (*M. corona*, Gmel.) has its whorls adorned with a coronal of curved, flattened spines. The longitudinal line of growth rise at base also in a secondary row of spines. Between the two is a flat space, banded with white on the bluish or chestnut ground. The surface is polished. In var. *bispinosa* the spiny crown is a double row of smaller cusps. In some forms the basal spines are missing. Sometimes there are no spines at all. Length, $2\frac{1}{2}$ to 5 inches.

Habitat.—Florida, West Indies.

The only mollusk that can kill one of these agile carnivores is the giant band shell, which overpowers it by main strength, and encloses it completely by the folds of its great foot. Any other rival discreetly yields whatever might be the subject of controversy, unless it is resigned to fight and be beaten.

The creature lives by preference in brackish water, feeding on clams and their kin, including the razor and the non-resistant oyster. Several individuals, often more than a dozen, may be seen in a circle around an oyster that has guardedly closed its shell. They patiently wait until the weary bivalve relaxes its

The Whelks. Trumpet Shells

muscle, and lets the shell gape. Or it may be a large *Fulgur perversa*, which has to lift its operculum in order to breathe. The *Melongenas* are ready at the signal, and all thrust in their snouts, long and tough, like black shoestrings. The victim quickly clamps them tight. But it must relax its hold frequently. Each yielding gives the snouts a chance to get a little further in. When the muscle is reached the rasping tongues soon disable it, and the victory is won. The "coon" oysters are *Melongena's* favourite food, though the gizzard plates in the stomach of this mollusk enable it to assimilate the toughest substances.

The **Open-mouthed *Melongena*** (*M. patula*, Brod. and Sby.), large and dark-coloured, with wide aperture, is sometimes remotely spiny on the shoulder. The shell is brown, banded with yellow or white. The lining is orange-pink. Length, 4 to 6 inches.

Habitat.—Panama to Mazatlan.

M. melongena, Linn., resembles the last species in its gaping mouth and the remote shoulder spines. Colour bluish brown; interior yellowish. The animal has a long slender head with eyes on the bases of the tentacles, a brown spotted yellow foot, broad and squarish at the ends. Length, 3 to 5 inches.

Habitat.—West Indies.

Genus HEMIFUSUS, Swains.

Shell thin, spindle-shaped, uncoloured or light yellow, spire shorter than the aperture, shoulders knobbed or spiny; canal open, wide, somewhat twisted. Six species.

The **Colossal *Hemifusus*** (*H. colosseus*, Lam.) is drawn out into slender spindle shape, its keeled whorls bearing compressed low tubercles. The elongated aperture gradually merges into the wide, open canal. The exterior is a uniform horn-yellow; aperture rosy. Length, 10 to 14 inches.

Habitat.—Indian Ocean, Philippines.

Genus NEPTUNEA, Bolt. (CHRYSDOMUS, Swains.)

Shell spindle-shaped, swollen in middle, colourless or dingy; whorls rounded, covered with horny epidermis; apex elevated, papillary; canal short; aperture oval; columella simple, smooth; operculum ovate, nucleus apical.

A circumpolar genus of eighteen species.

The Whelks. Trumpet Shells

The **Red Whelk** (*N. antiqua*, Linn.) is used for codfish bait, and is a favourite molluscan food among the poor of Great Britain. The liver is the tidbit, described as "more fat and tender than lobster." The Dublin marketmen call this whelk "barnagh." At Billingsgate market in London it is the "almond" and "buckie." *Antiqua*, the specific name, is chosen because this species is plentiful as a fossil in the Crag. Left-handed forms occur, fossil and living.

This mollusk is large, the average shell three or four inches long and two inches wide. Extreme specimens are eight inches long. The shell is solid, dull-lustred, yellowish or reddish, with faint spiral ridges. The Shetland Islanders convert them into "elegant lamps," hanging them in a horizontal position with the lighted end of the wick protruding from the canal. The eggs are laid in pouch-like capsules, attached to each other in close, overlapping clusters. The spawning time is late winter.

Habitat.—Northern Europe.

The **Ten-ridged Neptunea** (*N. decemcostata*, Say) is the large and striking whelk of the Maine coast, with ten winding keels of graduated sizes decorating its swollen body whorl. On the upper whorls but two keels occur. The mouth is wide open; the lining is pure white. The shell's exterior is dull and dirty, white or horn-coloured. The body is frequently pure white or flecked with black. The animal has the carnivorous activities of the whelk, *Buccinum*, with which it occurs, below low water mark. Length, 2 to 4 inches.

Habitat.—New England and Nova Scotia.

The **Ridged Neptunea** (*N. lirata*, Mart.) is a large Alaskan species, with light brown shell wound with nine to fifteen ribs, three seen on the spire. Sometimes the shell is smooth, by the suppression of these ribs. Length, 3 to 6 inches.

Habitat.—Northwest coast of North America.

N. harpa, Mörch., four to six inches long, closely ribbed, pale yellow, with oval, salmon-tinted aperture, occurs at Sitka.

Genus SIPHO, Klein.

Shell thin, pear-shaped, or spindle-shaped, with smooth, rounded whorls; lips simple; canal and spire produced; operculum ovate, with apical nucleus. Thirty-seven species.

Habitat.—Circumpolar.

The Whelks. Trumpet Shells

Stimpson's Sipho (*S. Stimpsoni*, Mörch.) is found in water from twenty to one hundred feet deep, off the coast of New England. It is clad in a thick, horny epidermis, which is sometimes velvety. There are seven or eight whorls, forming a very graceful shell, destitute of decoration, except for the crossing faint striæ and wavy growth lines. The canal is recurved. Length, 3 to 5 inches.

Habitat.—Arctic Seas to Cape Hatteras.

S. pigmæus, Gld., scarcely over an inch long, is found with the young of the large species. Its many whorls are invested with a velvety, corrugated, drab epidermis.

Habitat.—New England coast to Cape Fear.

Genus SIPHONALIA, A. Ads.

Shell thin, ovate, spindle-shaped; whorls bearing nodose longitudinal folds and spiral ribs; colouring variegated; canal short, twisted.

A genus of sub-tropical distribution, centring in Japan, but extending to America and Australia.

Kellett's Spindle Shell (*S. Kelletii*, Forbes) has colonised the California coast from its home in Japanese waters. Its brownish white shell is handsomely knobbed. It is found in the shallows at low tide. Length, 3 to 5 inches.

THE GIANT WHELKS. PEAR CONCHS. LIGHTNING SHELLS

Genus FULGUR, Montf. (BUSYCON, Bolt.)

Shell large, heavy, depressed below the apex, sculptured by fine revolving ridges crossed by radiating growth lines; columella drawn out into a slender stalk; body whorl large, aperture oval with elongated anterior canal; operculum horny; foot large; sexes separate; egg capsules keeled, on connecting ribbon.

The **Knobbed Whelk** (*Fulgur carica*, Gmel.) is one of the two largest and most characteristic univalve mollusks of the Atlantic coast north of Cape Hatteras. Its side partner is *F. canaliculatus*. These two great ocean snails are much alike in



WHELKS

- 1 Stimpson's Whelk, *Sipho Stimpsoni*.
- 2 Ridged Whelk, *Neptunea lirata*.
- 3 Kellett's Spindle Shell, *Siphonalia Kelletii*.
- 4 Red Whelk, *Neptunea antiqua*



THE EDIBLE WHELK, *Buccinum undatum*.

Used as food in Northern Europe. Specimens with spires coiled to the left are occasionally found.
Lower picture shows a mass of the egg capsules.

looks and habits. On any sandy beach between Cape Cod and the Gulf of Mexico one may pick up wave-worn shells of both, and their peculiar empty egg cases, always puzzling to the uninformed, who take home a string or two among other sea treasures to admire and wonder at with their friends. Naturally they do not associate the shells with these "seaweeds."

Sometimes a living shell with its dirty looking inmate is picked up where the tide left it stranded; at low tide they may be found clambering about on the slippery rocks or ploughing their way through the wet sand and gravel, with the muscular foot quite buried. Hollows in the sand are caused by whelks burrowing below the surface. The grayish colour, marked with dull brown, protects these mollusks from discovery except when in motion. The extended foot covers the bright red lining of the shell's thin lip. At rest the mollusk retracts the stout foot which closes the aperture with a deep-set horny door. A formidable series of knobs adorn the shoulder line of the outer whorl of the shell, each marking the end of a period of growth. This is the distinguishing characteristic of the species.

In Long Island Sound, on rocky shores, the shells never attain the size they do in the open, sandy surf-beaten beaches of New Jersey. Six to nine inches in length the adults range. Juvenile forms are found of all sizes.

The size and businesslike agility of this gigantic snail may lead you to quote Alice's knight:

Come, tell me how it is you live,
And what it is you do.

Ask the oystermen along the coast. They gnash their teeth and class the Fulgur among the numerous enemies of the helpless oyster. However, since the starfish and the little "drill" exist in so much greater numbers, ruthlessly destroying the young, the toll of the whelks may be small, though they are able to devour the oldest inhabitant of the oyster bed. They subsist chiefly upon live mollusks of various kinds.

A small round hole, bevelled as if by a steel tool, is made, and the whelk sucks out the juicy contents of the shell. The helpless bivalve gapes open. Little but tough muscle and ligament remains.

The long, hollow channel of the Fulgur's shell contains the

The Whelks. Trumpet Shells

muscular double siphon. One tube admits water to the gill chamber, the other discharges wastes. When the mollusk is in motion the siphon is extended beyond the end of the shell and upward. Under it the head protrudes, bearing the proboscis in front, and the waving tentacles, each with a little black eye on the side. The foot spreads broadly below the shell opening; the operculum lies flat on the posterior lobe. The shell is carried in a horizontal position, its spire directly above the operculum, its stem thrust forward.

Few observers have ever seen the giant whelk lay her eggs, though all know the long "egg ribbon" from which little whelks emerge in the perfect image of their parents. It is known that the process of egg laying is an exhausting one and takes considerable time and energy. The first of the parchment-like substance is extruded upon a pebble or shell fragment which is chosen as an anchor for the completed chain. The first few capsules are small and far apart on the string. Then begin the perfect egg cases, two keeled, and set close together. The string twists spirally and is often a yard long, with nearly one hundred cases.

Fresh ribbons are found during all the warm months along the Atlantic coast. In each case the development of the egg progresses, until the embryo stage is past. Then a round door opens on the lower floor of the chamber, on the side opposite the connecting string. Out tumble the little whelks and begin the life of independence on the sea bottom.

The **Left-handed Whelk or Lightning Shell** (*F. perversa*, Linn.) is much like the northern species, but the spiral turns to the left instead of following the snail fashion. The young shells are bright with zigzag brown lightning streaks that radiate from the spire, crossing the fine spiral ridges that decorate the whorls. The lip is lined with brown. The knobs are blunt. The body is black. The shells fade and whiten with age; the largest specimens are a foot long. They live on sandy beaches, and spend much time burrowing just under the surface for bivalves. They are preyed upon by *Melongena*.

Habitat.—Florida.

Sub-genus SYCOTYPUS, Gill

Shell with deep channelled suture, square-shouldered whorls, without knobs; hairy, thick, brown epidermis covers exterior; interior yellowish, smooth.

The **Channelled Whelk** (*F. canaliculatus*, Say) is distinguished from its companion by the channel that follows its sutures. The egg cases have not the double-keeled edge, but narrow to a sharp margin. In most particulars the two species are alike.

The Indians cut the long, white columella of the giant whelk into beads to make their wampum belts. Three beads were worth an English penny in early Colonial days in Massachusetts. A fathom string was worth five shillings. In the South the shells are often used to border garden beds and paths. Drinking vessels were made of them by Indians. Fulgur flower pots are often seen to-day in Florida. The sharp edge of the aperture made cutting tools for the aborigines. Length, 6 to 9 inches.

Habitat.—Cape Cod to Texas.

The **Pear Conch** (*F. pyrum*, Dillw.) has a depressed, unarmed spire, with a deep suture. The sculpture consists of alternately weak and strong spiral striæ and angular shoulder keels. Bands of pale brown cross the white ground of the whorls. The canal is long and tapering. Length, 4 to 5 inches.

Habitat.—Florida and Gulf of Mexico.

Genus EUTHRIA, Gray

Shell spindle-shaped, smooth; aperture oval, ending in short, recurved canal. Species, ten, widely distributed.

The **Dark Euthria** (*E. dira*, Rve.), liver-coloured when the ashy powder is removed, well represents the genus. Deep revolving channels, close together, engrave the surface. The spire has longitudinal folds. Length, 1 to 2 inches.

Habitat.—Monterey, Cal., to Sitka.

Genus CANTHARUS, Bolt.

Shell bucciniform, with swollen body whorl and narrowing to base; aperture and spire of about equal length; siphonal canal at posterior end of aperture; columella arched and faintly ridged. About fifty species in warm seas.

The **Painted Cantharus** (*C. tincta*, Conr.) has the form of a typical Buccinum, with surface finely ribbed both ways, somewhat tuberculated, with variegated markings of brown and white. Length, 1 to 1½ inches.

Habitat.—Florida, West Indies.

The Whelks. Trumpet Shells

C. cancellaria, Conr., is ash-coloured, has strong spiral ribs, crossed by longitudinal folds, forming fine tubercles. Lip strongly lined within; spire prolonged; canal recurved. Length, 1 to 1½ inches.

Habitat.—Gulf of Mexico.

THE TYPICAL WHELKS

Genus **BUCCINUM**, Linn.

Shell oval or oblong; spire elevated, acute; epidermis horny; colour dull ashen; aperture oval, large; canal wide, short; columella expanded, smooth; outer lip thin, smooth inside; operculum ovate, nucleus sub-marginal, small; radula prominent.

A carnivorous genus of few species, in northern waters.

The **Waved Whelk** (*B. undatum*, Linn.) is a circumpolar species which extends its range southward as far as New Jersey and the Mediterranean, varying from the type so far on American coasts as to induce some scientists to accept the name, *B. undulatum* of Müller. It has a steep spire of rounded coils, ridged with fine grooves and made wavy by crossing a dozen or more longitudinal folds that fade out at the middle of the body whorl. The animal is aggressively carnivorous, and has demonstrated its ability to adapt itself to varying circumstances.

It is not surprising to find in such a mollusk that the osphradium, or organ of smell, is very large. It lies like a plume-shaped gland in the wall of the mantle cavity close to the gill. One might easily mistake it for a secondary breathing organ. The third and largest in the series of curved and flattened organs on the left side of the body is the gland that secretes quantities of glary mucus.

The egg cases of this whelk are attached, and the mass looks like a coarse sponge when picked up on the beach. Sailors use them as a soap substitute under the name of "sea wash balls." Each capsule is a tough pouch like a large split pea, attached by its side. Several hundred eggs occupy each cell, and there are five hundred or more capsules in an average mass. As they hatch, the vigorous embryos devour the weak ones, so the numbers are greatly reduced. The development occurs in winter and requires about two months before the fry are ready to leave the egg capsule.

The voracity of this scavenger snail is its besetting weakness. A wicker basket baited with fish offal and lowered at night to a muddy bottom is drawn up loaded with whelks in the morning. The helpless lobster fisherman gnashes his teeth over the greedy mollusk which steals his bait over night, and then leaves the empty traps. The long lines set for cod are often drawn up with whelks on the hooks.

On the other hand, whelks have their enemies. Cod are especially fond of them. Forty or fifty shells are sometimes found in the stomach of a single fish. Quantities of whelks are used for bait in the cod fisheries. Hermit crabs are quick to occupy empty whelk shells. The people of Northern Europe count whelks among important sea foods—a staple, not a delicacy.

The Dublin method of cooking whelks is to boil them until they fall from the shell; then fry in butter until brown. A whelk soup which sounds “good enough to eat” is made somewhat like a clam chowder. The fried whelks are added to a vegetable soup, in which they boil an hour before being served. Boiled tender, whelks are eaten with oil and vinegar. In America they are unknown as food, though plentiful on the Atlantic coast.

The range of this species is from tide level to a depth of 650 fathoms, and from the Arctic Seas to the Mediterranean and New Jersey coasts. In sandy bottoms the shell is solid and strongly waved and ridged; in mud it is thin and smooth. The usual colouring is pale rusty, under a thin epidermis. Some are pure white. The body is dirty white, with black dots and streaks. Any species of such great geographical range is bound to show striking variations. The average size is three inches in length by two inches wide. A single specimen $6\frac{1}{2}$ inches long is probably the largest known. Pygmies represent the other extreme.

Each country has its own common name for this mollusk. It is called “the roaring buckie” by Scotch children who are told that by laying the shell’s mouth close to the ear one hears the murmurs of the sea imprisoned in its coiled spire.

THE IVORY SHELLS

Genus EBURNA, Lam.

Shell ovate, smooth, ivory-white, spotted with orange-red; epidermis dark; whorls shouldered; umbilical area large, set off

The Whelks. Trumpet Shells

by a strong rib; aperture white or tinged with violet; columella thickened.

Lamarck erected his genus upon a shell which turns out to be *Ancillaria glabrata*! This slip, however, is overlooked by Tryon, in view of the assemblage of species Lamarck made under this head. There are about twelve species inhabiting Eastern tropical seas.

The **Spiral Ivory Shell** (*E. spirata*, Lam.) has a deep channel as the sutural boundary of its whorls. There is an upper and a lower notch in the large round aperture; the white surface bears series of irregular brownish spots. The sharp apex is black. Length, 2 to 3 inches.

Habitat.—Ceylon, Philippines.

The **Square-spotted Ivory Shell** (*E. areolata*, Lam.) is ornamented by three regular rows of square brown spots on its swollen body whorl. There is room for but one row on the upper coils. This is the largest and most striking of the ivory shells. Length, 2 to 4 inches.

Habitat.—Ceylon, China Seas.

The **Japanese Ivory Shell** (*E. Japonica*, Sby.) lives in sandy mud off the coast of Japan. Women and children gather the mollusks for the markets where they are offered as a staple article of food.

Genus MACRON, H. and A. Ads.

Shell ovate, thick, with dark, tough epidermis; spire elevated; columella wrinkled; callous at posterior end; outer lip thin, with small anterior tooth; operculum ovate. West coast of America.

Kellett's Macron (*M. Kelletii*, A. Ads.) is a stout little whelk with a wide doorway, notched at top and bottom. A basal ridge around the whorl ends in a tooth on the outer lip. The smooth brown exterior is covered with a dark epidermal coat. Length, 1 inch.

Habitat.—Southern and Lower California.

M. lividus, A. Ads.; smaller, paler brown, with epidermis distinctly ridged, is found on Southern California beaches.



Giant Pear Conch or Knobbed Whelk, *Fulgur carica* (life size), and a section of the "egg ribbon." Several embryos develop in each flat capsule. At the lower end is a cluster of the conical egg capsules of a smaller mollusk.



GIANT WHELKS, OR PEAR CONCHS, AND EGG RIBBON

1 Left-handed Whelk, *Fulgur perversa*.

2 Egg Ribbon of *F. canaliculatus*. Several embryos develop in each capsule.

3 Operculum of *Fulgur perversa*.

4 Channeled Whelk, *Fulgur canaliculatus*.

CHAPTER VIII: THE BASKET SHELLS. DOG WHELKS

FAMILY NASSIDÆ

SHELL small, ovate; spire elongated; base of aperture a notch or short recurved canal; columella callous; operculum horny; nucleus apical. Body with forked tail; foot long and broad; siphon long; tentacles slender, bearing eyes; radula well developed; teeth arched, serrate. A world-wide marine family, near shores of temperate warm seas. Habits active, predatory.

Genus *NASSA*, Lam.

Characters of the family. Over one hundred species.

These shells have their name from their resemblance to the tapering, narrow-mouthed wicker baskets used in Europe to catch fish and lobsters in. The cancellated surface of the shells suggest basketry. The mollusks are taken in considerable quantities adhering to these baskets to which they are attracted through their keen sense of smell, and their corresponding appetite for fish, dead or alive. The peasants eat the species *mutabilis* in Italy.

The scavenger work done by these dog whelks certainly puts them on the white list of useful mollusks. The seashore is fresh and clean because they help other scavengers to remove such wrecks of fish and other creatures as the waves wash ashore. These, if left, would become vilely offensive in a short time. No better cleanser of a polluted aquarium is known than a handful of dog whelks.

The broad foot with its forked tail and lobed front is interesting to watch as it glides along leaving a trail in the mud. The animal finally rests under a small pellet of mud, at the end of the trail. What is intended as a mode of concealment is in reality a prominent sign board: "If your looking for the maker of this trail you 'll find him under a ball of mud at the end."

The Basket Shells. Dog Whelks

In the aquarium the sole of the foot is often applied to the surface of the water, the shell hanging downward, a familiar position assumed by certain fresh water snails.

The Nassas are very tenacious of life. They survive for months enforced hibernation in cabinets and neglected aquarium jars, and revive with no apparent damage when restored to their natural element.

The basket shells show an astonishing tendency to variation, bringing discouragement and chaos to the systematic student who wishes to draw sharp distinctions between species. About five hundred species have been erected already, three-fourths of which Tryon has reduced to the rank of synonyms. The American species are few.

The **Channelled Basket Shell** (*N. fossata*, Gould) is the largest species in the family. It is one to two inches long. The surface is sculptured with revolving ridges and grooves, which show distinct and white within the wide aperture. Longitudinal grooves cross the whorls, cancellating them finely on the spire, forming strong rounded nodules on the upper half of the body whorl. The exterior is brownish yellow and dull; interior ridged, polished, callous, bright orange. Columella excavated; lip toothed. The umbilicus leads out into a deep channel that winds around the base of the body whorl.

Habitat.—California.

The **Dog Whelk** (*N. trivittata*, Say), of our Atlantic seaboard is a familiar inhabitant of sandy shores from Maine to Florida. The long spire has close spiral ridges, crossed by stronger, beaded ridges. The sinus, deep between the whorls, bears a strong top row of nodules, tinted pink or yellow, and faintly banded below.

When the tide goes out these mollusks come quickly up from under the sand, and make for the water, the broad foot holding its forked tail erect, the tentacles waving ahead, and the siphon thrust out of the notch in the shell directly above the head. The shell lies horizontally upon the body; the small operculum is hidden by the spire. Fine dots of purple adorn the colourless body.

The **Worn-out Basket Shell** (*N. obsoleta*, Say) is eroded at the apex — a basket with its bottom badly damaged. This is a dark-coloured Nassa, brown or olive, lightened occasionally by a

paler band around the body whorl. The surface is spirally grooved, but faintly so, and crossed by lines of growth. The old shells are dilapidated affairs, with a sort of marine mould grown thick upon them, like an epidermis. The aperture is dark brown with white banding; the lip simple, a callus covering the columella.

The body is grayish and mottled, with the power to extend far out of the shell. Shell and body are well protected, for they are dingy, like the muddy sand in which they live. The latticed surface catches the sand, so that an exposed shell is hard to discern until it moves.

This *Nassa* lays its numerous egg-capsules in spring on the lining of the egg-collar of *Natica*, or on a dead clam shell, crowding them always close together. Each is an elaborately spiny, transparent object on a short stalk.

No mollusk of equal size is more in evidence on the Atlantic coast. Especially does it throng the muddy shores where by the emptying of streams the water is somewhat brackish. On mud flats, exposed at low tide, they may be seen by thousands, scrambling nimbly about doing scavenger duty. A dead crab or fish calls together an army of them, which soon dispatch the ill-smelling object. Obligated to find live prey, they bore the shells of bivalves, and are even suspected of eating each other at a pinch. The largest is an inch long.

Habitat.—Nova Scotia to Florida.

The **Lash Nassa** (*N. vibex*, Say) is the handsomest of the basket shells. Strong longitudinal ridges, set far apart, cross the fine spiral ones, forming nodules at the shoulder of each whorl. The shell is heavy; the toothed lip thick; the callus of the columella spreads out into a broad flat triangular patch on the body whorl. The colouring is chestnut and white, in bands and clouds. Length, $\frac{3}{4}$ inch.

Habitat.—West Indies, to Chesapeake Bay and Cape Cod.

The **Lean Nassa** (*N. mendica*, Gld.) has a slender, strongly sculptured shell, of fine revolving lines crossed by remote, prominent ridges, broken by the sutures. The exterior is marked with pale brown; the interior is white. Length, $\frac{1}{2}$ to $\frac{3}{4}$ inch.

Habitat.—Puget Sound to San Diego, Cal.

The **Fat Nassa** (*N. perpinguis*, Hinds) resembles *N. fossata* in its stout figure, and in other particulars, but it is smaller through-

out. The surface is finely cancellated, and marked with chestnut. The lining is bright orange. It never reaches an inch in length.

Habitat.—Southern California.

The **Slate Nassa** (*N. tegula*, Rve.) is dark gray in colour, with a pale band just below the noded shoulder of the whorl. The aperture is lined with smooth white enamel. Length, $\frac{3}{4}$ inch.

Habitat.—Southern California.

The **Netted Dog Whelk** (*N. reticulata*, Linn.), found on sandy shores from Norway to the Mediterranean, has been the subject of much study. It is an inch or more in length, a robust mollusk in a solid, cancellated shell, brownish white, often banded with chocolate below the suture. Back from its thin edge the lip is thickened and toothed; the columella is smooth with a wide-spread callus. There is considerable variability of sculpture from fine to coarse.

At the recess of each tide this mollusk buries itself in the sand in a slanting position, its lurking place betrayed by a little hillock. It gets into lobster pots for the sake of the bait.

Buried in the sand at the bottom of an aquarium, these mollusks will always respond to one stimulus unless it comes just after a hearty meal. Scraps of meat, fresh or stale, make an irresistible appeal. Bones with particles of meat adhering are soon buried by the mollusks. Simply passing a bit of meat over the sand, then withdrawing it, served the same purpose of drawing the animals, so strong is their sense of smell.

The eggs of this *Nassa* are laid on seaweed. The capsules are like flat purses, the size of a spangle, on short stems. These are attached to the stems of seaweeds, and overlap each other in a single row. The young escape from the capsule through a hole at the top. They have ciliated lobes by which they swim. The antics they cut are amusing to watch, and seem to be merely playful, but are probably a struggle to resist capture by swarms of infusorians.

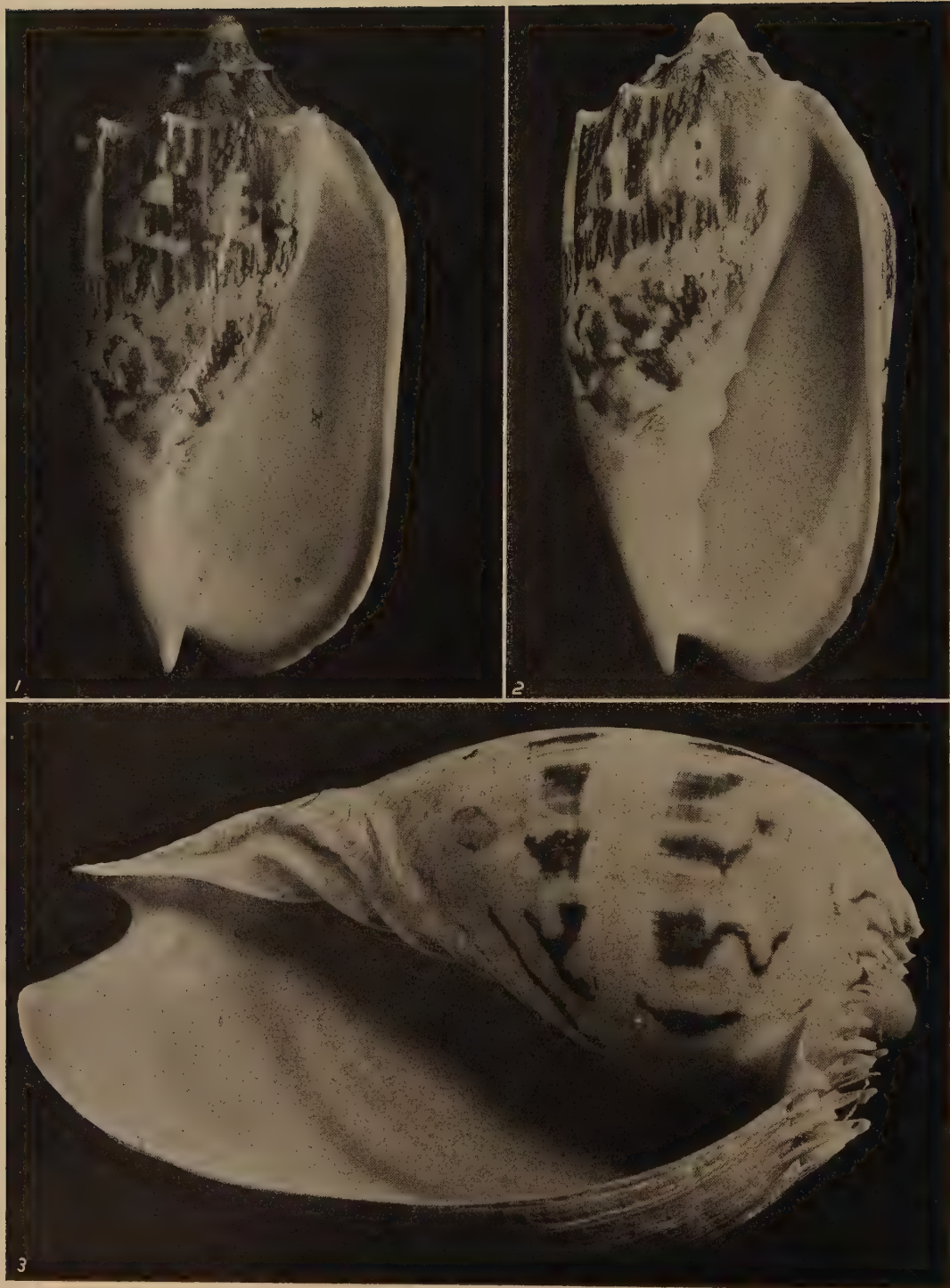
The robust *N. reticulata* does great damage in the *parcs* of Arcachon, where the famous French oysters are raised. Like our destructive "drill," the Nassas of all ages bore the oyster shells, and suck out the soft parts of their helpless victims. The tide sweeps, in bringing fresh thousands of these destroyers, so that combating them is a long, unequal fight.

Fortunate for our oyster growers the dog whelks of the



DOG WHELKS AND OTHERS

- | | | |
|---|-------------------------------------|--|
| 1 Ivory Shell, <i>Eburna Japonica</i> . | 3 <i>Euthria dira</i> . | 5 Dog Whelk, <i>Nassa trivittata</i> . |
| 2 <i>Macron Æthiopis</i> . | 4 Dog Whelk, <i>Nassa fossata</i> . | 6 Dog Whelk, <i>Nassa obsoleta</i> . |
| 7 <i>Cantharus tincla</i> . | 8 Chank, <i>Turbonella pyrum</i> . | |



[A VOLUTE AND A MELON SHELL

1, 2 Bat Volute, *Voluta vespertilio*, showing variation.

3 Melon Shell, *Melo Broderipii*

The Basket Shells. Dog Whelks

Atlantic prefer dead fish to live oysters, so they are a negligible, even though numerous, element in the fauna of the coast. Other mollusks are victims of the dog whelks' patient boring. They are even suspected of cannibalism. Finally, in their decline, small hermit crabs tear them from their shells, and take possession, each making a meal of the dismembered body of its victim.

CHAPTER IX: THE CHANK SHELLS

FAMILY TURBINELLIDÆ

SHELLS large, heavy, ventricose, smooth or tuberculated; columellar plaits transverse, near middle, far apart; aperture long; operculum thick, claw-like, with terminal nucleus. Animal shy, sluggish in movements. A small tropical family, allied to the Buccinidæ and Fusidæ.

Genus TURBINELLA, Lam.

Shell mostly fusiform, heavy; columella bearing one to five compressed plaits; epidermis horny or fibrous; operculum horny, pointed, small; surface of shell ornamented with a great variety of sculpture and colouring.

Several species are large-sized shells, qualifying for rank among the molluscan nobility. They have characters of *Murex* and *Voluta* joined.

The **Pear Turbinella** (*T. pyrum*, Lam.) was named by Linnæus *Voluta pyrum*. It has the characteristic folds on the columella which was his basis for thus classifying it. Threeblade-like plaits wind across the middle of the columella. The inner lip flares widely above. The outer lip is plain and thin. The canal is long and straight. The swollen body whorl is keeled, and coronated at the shoulder. The spire is depressed, and has a knobbed apex. The surface is light coloured, spotted with brown, under the olive-green epidermis; the lining is orange red. Young shells are brightest. Length, 4 to 7 inches.

Habitat.—Ceylon.

Besides being the type of its genus, the Pear Turbinella is the Chank or Shankh, the sacred shell of the Hindus, the national emblem of the Kingdom of Travancore. The images of the god Vishnu always carry a chank shell in one hand. The Vedas were stolen by the giant chank shell, according to the legend, and Vishnu took the form of a fish that he might go down and recover

the lost books and destroy the thieving mollusk. Every Hindu worships the sacred shell at the beginning of every prayer; otherwise his offering would not be received.

The chank fisheries of Ceylon and vicinity have great commercial importance. Divers bring up the "green chanks," alive and still invested with their green covering. These have perfect shells and bring the highest prices. They are shipped to Calcutta whence they are distributed through the ordinary commercial channels. At one time the chank fisheries of Ceylon yielded the Government a revenue of £4,000 per annum for divers' licenses alone. Six hundred divers were employed there. The value of the shells shipped into Calcutta and Madras in some years reached £15,000 sterling.

The Hindu artists carve and otherwise ornament chank shells; then they are suspended as oil vessels for the illumination of the temples. A reversed or left-handed specimen is worth its weight in gold. These rare shells are particularly revered in India, Siam, China and in Ceylon. The Chinese priests keep these curiously ornamented sinistral shells as sacred vessels in the pagodas, and employ them only on special occasions. Medicine is administered to the sick from them. The oil for anointing the Emperor is kept in one of these vessels awaiting the next coronation.

Most of the chanks are used in the manufacture of bracelets, armlets and bangles, an industry that centres at Dacca. A rude saw, operated by feet and hands both, cuts the shell into narrow rings or segments of circles. These are polished, painted, grained and inlaid with precious metals and gems. Elaborateness of ornamentation is seen also where cheaper materials, tinsel, spangles and glass beads, are employed. The Hindu women wear these bangles in great numbers on arms and ankles. After death they are buried with their wearers.

Smooth chank shells are used to put a high polish upon paper and glazed cloth; their weight and smoothness adapt them for such work, in skilled hands. The "button" is cut from the top, and strung as a bead, or "krantah," into necklaces. These are worn by all the Sepoy soldiers in the East India service.

The **Artichoke Turbinella** (*T. scolymus*, Gmel.) is the giant of this genus. Its turreted spire bears a series of six varices, the strongest on the last whorl, which gives this ponderous fusiform shell a distinct hexagonal form when viewed from above. The

The Chank Shells

exterior is yellowish white, under a thin, fibrous, olive epidermis. The columella and interior are flesh pink. Length, 8 to 10 inches.

Habitat.— Brazilian coast.

Vasum muricatum, Born., is a related form, stouter, armed with hollow sharp tubercles on the shoulder of each whorl, and three rows near the base. Length, 3 to 6 inches. Colour white, lined with pink.

Habitat.— Florida Keys, West Indies, Panama.



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UNIVALVE SHELLS OF TROPICAL SEAS

- | | |
|---|---|
| 1 Carpenter's Notch-Side, <i>Pleurotoma Carpenteriana</i> , Gabb. | 5 Mitre Shell, <i>Mitra intermedia</i> , Kien. |
| 2 Spindle Volute, <i>Voluta fusiformis</i> , Linn. | 6 Splendid Olive Shell, <i>Oliva splendidula</i> , Sbv. |
| 3 Spotted Auger Shell, <i>Terebra maculata</i> , Linn. | 7 Court Volute, <i>Voluta aulica</i> , Sbv. |
| 4 <i>Lyria Delessertiana</i> , Petit. | 8 Netted Olive Shell, <i>Oliva reticularis</i> , Lam. |

CHAPTER X: THE VOLUTES AND MELON SHELLS

FAMILY VOLUTIDÆ

SHELL usually thick, often shining, showy, usually large, fusiform, cylindrical, oval or globular; columella projecting anteriorly, with several revolving folds; aperture notched, canal not produced; apex blunt, papillary; operculum generally wanting; body highly coloured; foot broad in front; head dilated into flat lobes on which are borne the two sessile eyes at the bases of the tentacles; siphon large, lobed at base; radula with strongly cusped teeth.

A carnivorous family living at considerable depth in tropical and sub-tropical waters, chiefly in the southern hemisphere.

Genus **VOLUTA**, Linn.

Shell ovate or fusiform, thick, solid, spire usually short, shoulders of whorls usually angled, sometimes bearing nodes or spines, aperture rather narrow; columella with a thick callous deposit, and winding plaits; lip thickened back of the sharp edge; sometimes almost reflected. A remarkable genus whose distribution centres in Australian waters.

The volutes might be called the "spiral shells" were this trait not constant among the gasteropods of sea and land. They are named for the folds upon the columella, a character they do not monopolise by any means. The spire is always prominent and always has a rounded, mammillate apex. The operculum is absent except in *V. musica*. In spite of its lack of distinctive characters in the shell, this family is not hard to distinguish from the few other "first families" of the mollusks. They are handsome, aristocratic-looking shells, of graceful form, good size and elaborate ornamentation. Amateurs are often enthusiastic collectors of volutes, and many rare and valuable species are to be

The Volutes and Melon Shells

found in private cabinets. Our native species is one of the most rare and valuable sea shell to be found in American waters. Several tropical species have long been known only by single specimens in European cabinets.

M. Duhant-Cilly, in 1840, described the eggs of volutes and their development. The mollusks were seen in the clear water of Magellan's Straits, each clasping the shells of a dead bivalve. In the convexity of one valve the volute had deposited a membranous mass, resembling in shape and transparency a watch glass. Some looked milky; others showed three or four perfectly formed volutes swimming about in the now clear fluid. In February, the late summer of that region, the young have attained considerable size. The transparent capsule has become leathery and is three to four inches across, more than half the size of the mollusk that laid the eggs. D'Orbigny conjectures that it expands after coming in contact with the water.

The **Music Volute** (*V. musica*, Linn.) has its whorls adorned with sets of parallel revolving lines, which look like bars of music, set the ordinary distance apart. The typical form has its "notes" grouped in single lines directly above and below the bars. Fine dots are thickly scattered between the two rows of large spots. The ground colour is a creamy flesh tint. The lines are bright chestnut, the dots dark brown. A deep bluish chocolate underlies the other colours on the body whorl. Faint wavy lines set close cross the bars. Nodules on the shoulder of all the whorls become very prominent on the last one. The lip turns out; the thick margin is marked with short stripes of dark brown. The columella has five main folds on a thick callus.

This species exhibits great variation of colouring, but the pattern is practically constant. Shells vary in length from two to four inches. One is pinkish red and small, *var. carneolata*; another is elongated in form, with pale colouring, *var. thiarella*. *Var. laevigata* lacks tubercles; *var. sulcata* has ribs from its tubercles, and is pale fawn-coloured.

This West Indian volute is the only species having an operculum. This is shaped like a long oyster shell, with the nucleus at the apex. The eggs are laid in flattened oval capsules the size of a finger-nail, in the concave of deep bivalve shells, to which they are glued singly, three or four in each shell.

The **Flag Volute** (*V. vexillum*, Lam.) is a small flesh-tinted

shell with narrow bands of orange revolving around its whorls. Faint cloudings of the same colour often occur, and blotches of it mark the nodules on the shoulder of the body whorl. The apex is very sharp.

This very distinct and rare species is three to four inches long, and comes from the Indian Ocean.

The **Waved Volute** (*V. undulata*, Lam.) is also marked with wavy lines of rich chestnut — a flag with its stripes running longitudinally instead of spirally. It is three to four inches long, fusiform and slender, as elegant in shape as in colour and pattern.

Habitat.—Australia.

The **Imperial Volute** (*V. imperialis*, Lam.) wears a crown of upturned hollow tubercles on the outer three whorls of the peaked spire. Over the shining salmon-coloured surface is a netted pattern made of zigzag chestnut lines, merging occasionally into triangular blotches of solid brown. The pattern is the same on the spire, but the colour is darker.

This shell has always been the admiration of conchologists, and from them received the names, "Chinese Emperor's Crown," and "The Crown of the Great Mogul."

A cross section of a young shell shows the thick walls of the whorls to be made up of several layers of ivory-like substance, including the thick, almost translucent lining. The plaits of the columella are faint in the aperture, but they become very distinct as they wind toward the smooth, knob-like apex, which is almost filled solid with the callus. Length, 5 to 8 inches.

Habitat.—Philippine Islands.

The **Magnificent Volute** (*V. magnifica*, Lam.) is thinner than the average large shell in this genus, and its whorls are not knobbed. The spire is elevated, and ends in a rounded papilla. The outer lip flares, making a wide aperture. The creamy ground colour is banded with dark brown in a reticulated pattern. Alternating with these dark bands are pale ones in which the same zigzags are faintly discernible. Young shells show a brighter pattern and more contrast than older ones. The lining is a reddish orange, especially bright on the columella and lip.

This is one of the largest and most distinct of the species. It is found half burying itself amongst weeds and ooze on sandy and muddy flats beyond tide mark. Length, 6 to 12 inches.

Habitat.—East Australia.

The Volutes and Melon Shells

The **Bat Volute** (*V. vespertilio* Linn.) is the most variable species in the genus. Gradually collections have acquired specimens forming a series of gradations between types assigned to specific rank by scientists in earlier days. Lamarck made four species of the specimens within his reach. These have been reduced to varieties.

The typical shell is short and broad-shouldered. Tubercles, sharp, flattened and with their points curving backward, rise prominently from the shoulders of the whorls. Zigzag bands of dark brown cross the whorls on a ground colour of pale chocolate. The spire is more yellowish. Triangular patches of paler colour form a band below the most prominent tubercles. The aperture is lined with white enamel. The lip lining has a tawny edge. Possibly the hooked tubercles on this shell suggested to Linnæus the prehensile hooks on a bat's wing. Length, 3 to 5 inches.

Habitat.—Philippines, Moluccas.

The **Courtier Volute** (*V. aulica*, Sby.) has the elegant shape of the mitres, tapering gradually to each extremity. It wears remote, flattened tubercles on the sloping shoulders of the body whorl, but knobs are barely suggested on the whorl above, and the spire is smooth. The flesh-coloured, polished surface is finely covered with longitudinal hair lines of chestnut. Clouds or flames of salmon colour revolve in bands around the shell. The bands are sometimes edged with rows of remote, dark spots.

For a long time this species was known only by a single specimen in the Duchess of Portland's famous collection, which is now in the British Museum. Then Mr. Cuming obtained some beautiful specimens in the Sulu Archipelago. These differ from the type by being tuberculated. Though others have been collected since, the species is still rare, and highly valued. Length, 3 to 5 inches.

Habitat.—Sulu Islands.

The **Handsome Volute** (*V. festiva*, Lam.) is the rarest of all. The whorls are longitudinally ribbed, like a harp shell. The spire is elongated above a noduled shoulder; the apex is a rounded knob. The flesh-white ground is painted with interrupted bands of orange red, the pale areas between the bands narrow and marked with short brown streaks in twos and threes. The aperture is orange.

One worn specimen was the only material Lamarck had when he described this species. Three bright, perfect specimens in England were accessible to Reeve in 1850. They came from the east coast of Africa, but nobody knows what locality.

The **Large-spired Volute** (*V. megaspira*, Sby.) is slender and fusiform, with smooth convex whorls, ending in a papillary apex. Zigzag streaks of chestnut paint a pinkish tawny ground. The aperture is small, ear-shaped, with pinkish lining.

This Japanese species is used for food. It is about 4 inches long. The shell is rare in collections.

The **Junonia Volute** (*V. Junonia*, Chemn.) is a rare species, confined to deep water, and found nowhere but on the east and west coasts of Florida. It has a slim ovate or spindle form, with a long aperture and short, pointed spire. The creamy surface is covered with spiral rows of squarish orange spots which follow the whorl deep into the shell. The columella has four sharp oblique folds. The lip is thin and lined with white.

This is the "Peacock Tail Volute" of Reeve. The American collectors fondly call this precious shell "Junonia." The possessor of a perfect specimen with its spots still dark and bright is to be congratulated. Once the demand for these shells was so great and the supply so short that a perfect specimen of good size would sell for \$200. Naturally, collectors searched diligently for them. Though by no means abundant, yet they may be had now at from \$1.00 to \$30.00, according to size and condition.

The island of Sanibel, a reef on the west coast of Florida, is classic ground for conchologists, so large is the number of molluscan genera and species represented. It seems to be the meeting ground of the Atlantic and Panama faunas, suggesting that far off time when no intervening land separated these now dissevered regions.

On Sanibel one may confidently look for Junonias. They are supposed to live in water off shore, but dredges are not effective tools to capture rock-loving mollusks. When the northwester comes down across the Gulf, churning the sea to its rocky depths, a Junonia may be unexpectedly flung ashore, and buried in sand. The morning after such a storm the Floridians and the conchological aliens in their midst go forth to gather the spoils of the gale. The sophisticated native digs in the sand drift on a shore line which has faced the storm, and he is oftenest and best rewarded.

The Volutes and Melon Shells

The ordinary beach-combing methods may recover a dull, worn Junonia, but a bright, fresh one is rarely to be found in the debris on the sand.

Have you "confidently looked for Junonias" on the beach at Sanibel? Discouraged friend, so did I, and neither did I. But a friend gave me a fair specimen that a friend of hers had found on the beach at Marco, farther south. Cheer up! Sanibel is too popular; too faithfully are her beaches scanned. Try new places facing the Gulf between Key West and Tampa. Your disappointment if you fail will be lessened by the large collection of other species you are sure to make.

There is a volute whose position seems to be intermediate between Voluta and Cymbium. This is the large **V. mamilla**, Gray, whose rounded whorls culminate in a knob-like apex, the nucleus bent to a lateral position and quite hidden from sight. In its juvenile stages this apical whorl is disproportionately large, a huge bulb, which led early conchologists to consider the young shell a monstrosity.

The thin outer lip of this shell flares, the body whorl is deeply concave, and the columella is drawn away, forming a deep aperture. The lining is orange, the columellar folds and the lip margin have the brightest colour. Length, 6 to 10 inches.

Habitat.—Australia.

Genus LYRIA, Gray

The beautiful **L. Delessertiana**, Petit, represents a small genus half way between the mitres and the volutes. The shell is ovately spindle-shaped, with elegantly tapering spire. The solid whorls are deeply cut with longitudinal grooves. The aperture is narrowly ovate; the columella has numerous cross folds, the lowest two much larger than the rest. This shell looks like a handsome piece of carved ivory. Colour, orange, banded with white. Length, 1 to 2 inches.

Habitat.—Madagascar.

THE MELON SHELLS

Genus MELO, Linn.

Shell large, thin, ventricose, ovate; spire short, depressed, with knobbed apex; whorls few, smooth, angled, coronated or

not, posteriorly; aperture wide, oblong; columella with several oblique folds; outer lip simple, acute, cut off in front. Tropical carnivorous genus of three distinct species. The young are arranged in strings, without egg-shells, in the oviduct of the parent, where they hatch and attain some degree of growth before being extruded.

The **Indian Melon Shell** (*M. Indica*, Gmel.) is lemon or orange yellow, smooth, with some blotches of brown in three obscure zones outside. The distinction of this species is the drawing in of the posterior edge of the last whorl until it nearly obliterates all signs of the very small spire. Length, 6 to 9 inches.

Habitat.—Indian Ocean.

The **Diadem Melon Shell** (*M. diadema*, Lam.) has a diadem of stout, erect spines, set far apart around its depressed spire. The ground colour is yellow, marked with zigzag lines and irregular patches of chestnut. Three revolving bars of dark chestnut cross the longitudinal zigzags. The lining is plain orange. This shell is so deeply concave as to hold nearly a gallon of water. Length, 6 to 13 inches.

Habitat.—Indian Ocean, Australia.

Genus CYMBIUM, Klein

Shell oval-oblong, ventricose, thin; spire short, depressed, deeply channelled, the outer whorl forming a flat edge encircling the globose nucleus; aperture oblong, wide; lip thin, flaring, simple; columella with several oblique plaits. Animal large; foot partially covering shell which is embedded in it; mantle reflected over shell; operculum, none. Four species. A peculiarity of the genus is that the shelly matter is deposited not only by the mantle but also by the great foot.

Habitat.—West Africa.

The **Snout Cymbium** (*C. proboscida*, Lam.) is a large, thin, yellowish shell, with the characters of the genus. When alive the shell has a glaze deposited upon it by the enveloping mantle.

The young are hatched within the parent's oviduct, and remain there until the shells are an inch long. A brood consists of four or five. When they are cast forth to take care of them-

The Volutes and Melon Shells

selves they are fairly able to do so. High shore winds are apt to bring in quantities of this mollusk's fry, called "yet." The natives of Senegal use them for food. Length, 8 to 12 inches.

Habitat.—West Coast of Africa.

A smaller species, *C. olla*, Linn., 3 to 5 inches long, inhabits the Mediterranean coasts of Spain and Northwest Africa. It is of a pale tawny colour.

C. Neptune, Gmel., 6 to 10 inches long, is yellowish or brownish red. *C. cisum*, Lam., is pale brown, elegantly marbled with chestnut. It is 3 to 5 inches long. Both are found on the west coast of Africa.



1, 2 The Musical Volute, *Voluta musica*.

3, 4 The Junonia, *Voluta Junonia*.



THE IMPERIAL VOLUTE, *Voluta imperialis*

CHAPTER XI: THE MITRE SHELLS

FAMILY MITRIDÆ

SHELL fusiform, solid, sometimes ovate-oblong; spire pointed, never papillary; columella plaited, the smallest plaits nearest the base; aperture narrow, often half as long as the shell; lip thin, usually toothed; epidermis thin or wanting. Animal with small, narrow head, bearing tentacles with eyes and a cylindrical extensile proboscis; mantle enclosed; foot small; radula variable, the laterals in many broad and comb-like; siphon long, with anterior appendage.

Genus MITRA, Lam.

A large genus between *Voluta* and *Marginella*. Species, 200, in Tropics; the finest inhabit Australia and the Philippine Archipelago. They are gregarious, nocturnal mollusks, avoiding the light, hiding by day under rocks and coral masses along the reefs. Some burrow in sand. The heavy shelled species are sluggish. All are most active at flood-tide. Ribbed species crawl about coated with sandy mud, which is a protection from enemies. Some species emit a purple fluid when disturbed. The shells are among those most desired by collectors.

American tropical species are among the large and gaily painted forms. Those which dare the colder shores are smaller and less ornate. Dr. Dall describes seventeen species on our southwest coast.

The **Episcopal Mitre** (*M. episcopalis*, d'Arg.) is fortunately a shell widely distributed in tropical seas, else it would not be within the reach and means of amateur collectors. As it is, no one needs to go without it. Its tapering spire of smooth, solid whorls is creamy white, overlaid with orange spots in regular winding rows. The spots just below the sutures are large and irregular. Those farther below are orderly close squares. The large spots are darker than the others. The lip is toothed toward its base. Length, 4 to 5 inches. Ceylon, Philippines.

The Mitre Shells

The **Papal Mitre** (*M. papalis*, Linn.) is thick and stout, painted with close spots of purplish crimson on a white ground, the spots uniformly small and squarish, often touching each other. The lip is crenate. Length, 3 to 4 inches.

Habitat.—Island of Annaa, Pacific Ocean.

The **Pontifical Mitre** (*M. pontificalis*, Lam.) is smaller than the two already described, and has its whorls strongly coronated with a spiral row of triangular cusps that stand erect. Below these are some impressed lines deeply punctured with rows of pinholes. The white ground is painted with irregular rows of orange-red spots. The animal is cream-coloured, with opaque white dots. Length, 2 to 3 inches.

Habitat.—Annaa and Tahiti Islands.

Belcher's Mitre (*M. Belcheri*, Ads.) is a handsome fusiform shell, strongly chiseled with revolving ribs; the wide sulci which separate the ribs are crossed with fine striations. A thick black epidermis coats the white surface while the mollusk is alive. Length, 4 to 5 inches.

Habitat.—Deep water off the coast of Central America.

Swainson's Mitre (*M. Swainsoni*, Brod.) is represented by a variety, *Antillensis*, Dall, found in deep water off Cape Lookout and among the West Indies, and in the shallower regions on the west coast. It is a slender, graceful form, with slightly rounded whorls scored with shallow, spiral lines, cancellated by cross lines of growth. The outer lip widens a trifle at base. The columella bears the four strong, oblique folds near the middle. Length, 3 to 4 inches.

The **Moor Mitre** (*M. maura*, Swains.) a dark brown, fusiform shell, faintly lined both ways, with conspicuous ridges on the columella, is, while alive, covered with a black epidermis. Length, $1\frac{1}{2}$ to 2 inches.

Habitat.—California coast.

Genus MITRAMORPHA, Ads.

Minute shells of this genus have stouter shape, but most of their characters proclaim their relationship with the true mitres. The columellar folds are often lacking.

The **Rough Mitramorpha** (*M. aspersa*, Cpr.) is brown and strongly cancellated. Length, $\frac{1}{8}$ inch.

Habitat.—California.

CHAPTER XII: THE MARGIN SHELLS

FAMILY MARGINELLIDÆ

SHELL pear-shaped, porcelanous, smooth or with ribs, polished; spire short or immersed; body whorl large; aperture nearly the whole length of the shell; outer lip with a narrow, thickened margin, toothed or smooth within; columella distinctly plaited; operculum usually wanting; foot large, square in front, tapering behind; mantle reflected over shell; tentacles close, bearing eyes; radula like that of the volutes.

A family of small shells related to the Cowries, Olives, Mitres and Volute. The principal genus has over two hundred species.

Genus MARGINELLA, Lam.

Characters of the family. Tropical or sub-tropical species in both hemispheres.

The **Bubble Margin Shell** (*M. bullata*, Born.), a giant among pygmies, is pale, smooth, ovate oblong, the rounded rim of the outer lip shaded to orange. The spire is immersed, leaving a shallow pit; the columella has four clean-cut folds. Length, $2\frac{1}{2}$ to $3\frac{1}{2}$ inches.

Habitat.—Bahia, Brazil,

The **Spotted Marginella** (*M. guttata*, Dillw.), is flesh-coloured, obscurely banded with brown, and flecked all over with opaque white spots. The rim is thick and bears a few spots of reddish brown. This small, broad shouldered species occurs abundantly. Length, $\frac{3}{4}$ to 1 inch.

Habitat.—West Indies to Beaufort, N. C.

The **Ruddy Rim Shell** (*M. carnea*, Storer) is orange red outside, and white on lip and columella, with a median white band. Length $\frac{3}{4}$ inch.

Habitat.—Tampa Bay to West Indies.

M. apicina, Menke., about $\frac{1}{2}$ inch long, white, or tinged with orange, blue, pink, or purple; faintly banded with a darker

The Margin Shells

shade, occurs from Cape Hatteras to the West Indies. There are usually a few chestnut spots on the lip margin.

Variety **borealis**, Verr., $\frac{1}{2}$ inch long, occurs from Rhode Island to Cape Fear.

The **Pear-shaped Marginella** (*M. pyriformis*, Cpr.) is a minute white shell, $\frac{1}{8}$ of an inch in length, sometimes tinged with orange.

Habitat.—Monterey to San Diego, Cal.

Genus ERATO, Risso

Shell obovate, polished; spire short, conical, distinct; aperture narrow, long; outer lip toothed, thickened in the middle; columella plaited. Shell and animal look like a *Cypræa*.

E. columbella, Menke., is a little rosy "coffee-bean" shell resembling *Trivia*. Length, about $\frac{1}{3}$ inch.

Habitat.—Santa Barbara, Cal.

E. Maugeriæ, Gray, represents the genus from Cape Hatteras southward to the Florida Keys and westward to Texas.



MELON SHELL AND MITRE SHELLS

- 1 *Melo diadema*. 2 *Mitra Belcheri*. 3 *Mitra granulosa*. 4 *Mitra episcopalis*. 5 *Mitra dactylus*.



MARGIN SHELLS, AND OTHERS

- | | |
|---|--|
| 1, 2 Red-mouthed Olive, <i>Oliva erythrostoma</i> . | 4 Margin Shell, <i>Erato viellina</i> . |
| 3 Margin Shell, <i>Marginella labiata</i> . | 5 Bubble Margin Shell, <i>Marginella bullata</i> . |
| 6 Snout Melon Shell, <i>Cymbium proboscideale</i> . | |

CHAPTER XIII: THE OLIVE SHELLS. RICE SHELLS. HARP SHELLS

FAMILY OLIVIDÆ

SHELL cylindrical or fusiform, spiral, highly coloured, porcelainous, polished; without epidermis; columella, lip, sutures and spire more or less covered with enamel deposits; outer lip simple; aperture long, obliquely notched below; operculum small or wanting; foot large, grooved above, with semi-lunar extension in front; posterior end prolonged into a point; mantle reflected over shell, forming large, tubular siphon in front, and a whip-like prolongation behind, which lies in the spiral, grooved suture; radula present; eyes borne on tentacles, or wanting. A tropical family, including few living genera.

Genus OLIVA, Brug.

Shell oblong, smooth, thick, heavily enameled, without epidermis, colour laid on in two layers in different patterns simultaneously by mantle folds; spire short; suture canaliculated; columella plaited; aperture long, operculum wanting. A tropical genus of about a hundred species, distributed chiefly in Central America, the Philippines, Mauritius and Ceylon. This is one of the genera in which the foot secretes the shell, at least in part.

It is a trick of some shell dealers to remove with acids the outer surface of an olive shell which exposes a layer with quite different pattern. The shell may now be palmed off on an inexperienced collector as a different species or a freak of nature.

The **Red-mouthed Olive** (*O. erythrostoma*, Lam.) has one dependable character, the deep orange-red aperture, but its exterior varies surprisingly, forming several distinct varieties. The shell is thick, heavy and somewhat swollen, below the pointed spire. The surface generally bears more or less distinct wide revolving bands. The pale creamy ground is sometimes covered

The Olive Shells. Rice Shells. Harp Shells

almost to the lip by deep chocolate, banded with chestnut. At the other extreme the shell is china-white, faintly mottled and banded with fawn colour or violet.

Different schemes of painting intermediate between the very dark and very light forms are seen in a moderately complete series of shells. These mollusks inhabit muddy sand in deep water. Length, 2 to 3 inches.

Habitat.—Ceylon and the Philippines.

The **Moor Olive** (*O. maura*, Lam.) is one of the commonest and most variable species in the genus, and one of the handsomest. It may be known by the tumidity of the shell toward the depressed spire, and the callosity at the posterior end of the rather wide white-lined aperture. There are forms with burnt orange exterior, faintly banded. Others are deep grayish chocolate of almost solid colour. Olive forms with flame-like streaks of deeper shade in broad bands are common. Lamarck's type was uniformly dark-coloured; the streaked, zigzagged and mottled forms he called varieties. The base of the columella has a tinge of red in nearly all of these forms. Length, 2 to 2½ inches.

Habitat.—Indian Ocean to Australia.

The **Tiger Olive** (*O. tigrina*, Lam.) is smaller and broader, with fine dark blue dots sprinkled thickly over an ash-coloured ground. The interior is white. A dark brown form is also described.

Habitat.—East Africa to Philippines.

The **Two-plaited Olive** (*O. biplicata*, Sby.) is a thin, smooth, bluish-gray shell, its suture brown. In size and form this shell is very like an olive. The blue occasionally gives way to dark brown or olive; some forms are nearly white. The aperture and the wide callus on the columella are violet-tinged. Two distinct folds on the base of the axis justify the name.

These little mollusks gather in companies just below the level of the sand, burrowing for food with siphons at the surface for fresh water. Professor Keep says they migrate rapidly, and a "school" of them is not easily located. He found them once by thousands on a beach, directly after the tide had left it. He says: "You must go at the very lowest morning tide, and search till you find their beds. . . . I took some of them home and put them in a jar of beach sand and sea water. The plough-shaped foot quickly digs a hole in the sand, and the long breathing-

siphon which curls up through the canal and reaches through the sand up to the clear water, is like the trunk of a swimming elephant." I have found them just under the muddy sand along the breakwater at San Pedro, but not in companies, as Professor Keep did.

The shells are offered for sale in quantities by curio dealers in coast towns. Portières are made by stringing these shells, prepared by grinding off the apex. I have seen stringers alternate shells with glass beads. To many people these clattering strands seem desirable household impedimenta to hang in doorways, or as draperies for windows. The shells retain their prettiness though mutilated, and devoted to inappropriate uses.

The stringing of these olive shells began with the Indians who used them as money. These strings of shells beads were called *Kol-Kol*.

The **Angled Olive** (*O. angulata*, Lam.) is distinguished by the angular swelling of the body whorl, above the middle, and by the great thickness of the shell. The aperture is much wider than is usual in the genus. The pale ground is finely mottled with grayish brown; over this under pattern are laid longitudinal bands of dark brown in graphic, zigzag lines. The pink callus of the interior is reflected over the thick margin of the lip. The oblique folds on the columella are anterior and rather faint. The spire is short, its suture narrow and deep. The young shell lacks the angle, but the pink lining distinguishes it from species with similar markings. Length, $2\frac{1}{2}$ to $3\frac{1}{2}$ inches.

The **Porphyry Olive** (*O. porphyria*, Linn.), 4 inches long, is the largest species. It is flesh-coloured under a complex network of longitudinally zigzag brown lines. Crowding of these lines gives the effect of irregular broad bands of chestnut. The callus reflected over the lips from within is violet-coloured and lustrous. The columella is yellowish brown with faint ridges.

The paler areas of the surface are triangles outlined with brown. They look like a vast encampment of tents, of all sizes, on a hillside. The name "Camp Olive" is thus accounted for. The resemblance to porphyry is also pronounced.

This agile mollusk is found in sandy mud flats at low tide.
Habitat.—Panama to Mazatlan.

The **Netted Olive** (*O. reticularis*, Lam.) has an intricate lace pattern of fine lines of brown woven upon a white ground,

The Olive Shells. Rice Shells. Harp Shells

in the typical form. The colour is slightly faded in three revolving bands. Fine lines, gathered as if into fringes edge the sutures. The columellar folds are numerous; only the anterior ones are strong. The apex is elongated.

From the type, divergence in colour is great, leading from dark rich brown to white. But the netted pattern is rarely lost or covered up. The shells are heavy. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.— West Indies, Florida.

The west coast form of the netted olive is *O. araneosa*, Lam., a somewhat larger, broader shell, and less cylindrical, being swollen above the middle. The spire is prominent; the body whorl drawn in below the narrow suture. The creamy ground is overlaid with chestnut or darker brown in zigzag series of indistinct spots.

Habitat.— Panama to Lower California.

The **Lettered Olive** (*O. litterata*, Lam.) is slender and tapers toward both extremities. The creamy ground colour bears a close netted pattern in pale brown spiral bands separating the brighter ones. Here and there are dark figures suggesting printed characters or hieroglyphics.

The narrowing anterior end of the shell separates this species (and not very satisfactorily) from *O. reticularis*. The aperture is lined with violet, sometimes faded almost to white in cabinet specimens.

These polished olive shells, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, are picked up on sand beaches from Beaufort, N. C., to Key West, and throughout the West Indies. They apparently live in colonies. I have found them alive on the inland beaches of Marco Bay, on the West coast of Florida. The two thin reflexed mantle flaps and the broad foot have the same colours and markings as the shell, and blend well with the wet sand and gravel as the creature ploughs along, half-buried, to overtake the receding water. Probably the small thin-shelled bivalves met on the way furnish daily rations of fresh meat.

These "Panama shells" are collected and strung to make portières which sell at good prices to Northern tourists.

Three species are markedly different in shape from the typical cylindrical olive shell.

The **Fusiform Olive** (*O. fusiformis*, Lam.) is broad shouldered with a tapering spire and base. Its pale surface is marked with

brown zigzags, remote, or so close as to form areas of solid colour. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.— West Indies.

The **Gibbous Olive** (*O. gibbosa*, Born.) has a stout ovate shell, almost a cone in outline, not unlike that of *Strombus pugilis*. The callus on the columella, as it approaches the spire, widens and thickens, forming a great swelling, which spreads over the coils, and winds a white band to the apex. The surface is creamy white, darkened by an intricate network of chestnut, spirally banded with white below. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.— Ceylon, West Africa.

The **Brazilian Olive** (*O. Braziënsis*, Lam.) is a more distinct cone, for its spire is flat. It is like a helmet shell. The callus that overlies it leaves the sharp apex protruding, and the greater part of the suture open. There is a thick round patch of callus at the head of the columella. The base of the shell has a broad, shiny zone of fawn colour like the lining of the lip. The body whorl is crossed with fine, close-set lines ranging from chocolate to pale violet. Length, 2 to $2\frac{1}{2}$ inches.

Habitat.— Brazil.

THE RICE SHELLS

Genus OLIVELLA, Swains.

This genus is very small in number of species, and in size of the shells. These are cylindrical, produced into tapering spires; they have thin horny operculums. The mollusks live under the surface on sandy beaches. A lifted pellet of sand reveals their presence. They have no eyes, nor any need of them. The foot spreads into two lobes which envelope the shell. Thrown into the water, an Olivella uses these lobes as swimming organs, by which it speeds to cover. These shells are sold by the quart for use in "fancy work."

The **Little Olive** (*O. mutica*, Say), $\frac{1}{2}$ inch long, or less, is a delicate thin spiral, tapering to both ends. Between the lower suture and a basal white band the body whorl is crossed by wavy lines or bands of chocolate on a pale, almost translucent ground. The aperture is half of the shell's total length.

Habitat.— North Carolina to West Indies.

The **San Pedro Rice Shell** (*O. Pedroana*, Conr.) has a slim, shining little shell, coloured bluish or brown, and sometimes striped with yellow. It is about $\frac{1}{2}$ inch long. It lifts up a small pellet of sand, as if by thrusting up its head to see if the tide has gone away and left it. I have found them in plenty on San Pedro Bay, Cal.

The **Twisted Olivella** (*O. intorta*, Cpr.) is small, too, but stout in build compared with the last species. The pale surface is spirally striped with yellow. The suture is deep; the columella bears one fold, and spreads into a large callus above. The outer lip is thin and curved at the base.

Habitat.—California.

Genus **ANCILLARIA**, Lam.

Shell oliviform, of few coils, thin, polished; sutures filled with callus; lip flaring, frequently squared anteriorly; a strong spiral ridge ends in a tooth near base of body whorl; foot fissured, very large, reflected over shell; mantle prolonged in front into a long siphon; tentacles united to form veil; eyes wanting.

A small genus of seventeen species of active, gliding mollusks, in tropical waters, chiefly East Indian.

The **Cinnamon Ancillaria** (*A. cinnemomea*, Lam.) is the type, though by no means as large as the largest species in the genus. The colour is cinnamon yellow, with two bands, brown and white, around the spire. The lining is a paler tint. The flaring lip has a squarish corner below. The white columella bears fine oblique striations. The revolving basal sulcus ends in a tooth on the lip. Length, 1 to $1\frac{1}{4}$ inches.

Habitat.—Red Sea, Persian Gulf.

A mauritiana is like a melon shell in form and in the capacity of its deep aperture. Its colour, thinness and smooth surface are also suggestive traits. Some are pure white; all have a shiny white columella. Length, $1\frac{3}{4}$ to $2\frac{1}{2}$ inches.

Habitat.—Madagascar, Australia.

The **Polished Ancillaria** (*A. glabrata*, Linn.) has a spire as long as the wide aperture. This handsome fusiform species is

yellow and white and highly polished. The basal grooves lead to a deep umbilicus. Length, 2 to 3 inches.

Habitat.— West Indies.

THE HARP SHELLS

Genus HARPA, Lam.

Shell large, ventricose, longitudinally ribbed; columella polished, broad and fluted above, narrow and smooth below; outer lip thickened; aperture large; operculum, none.

A very distinct genus of nine species, distributed in all tropical waters except those of the Atlantic Ocean.

The general outline of these shells, and the parallel series of ribs stretched from spire to base, justify the name. Harpalis, Harparia, Lyra, Cythara, Buccinum—all these generic names have been applied to members of this small group. All credit them with grace of form and perfection of finish befitting instruments of music. To these attributes are added richness of colouring that alone would rank them above most other shell families. Combining colour harmonies of unsurpassed beauty with symmetry and grace of line and curve, the harp shells have perhaps excited more universal admiration than any other group of the “aristocratic shells.”

There is no door in a harp shell shutting the world out when the mollusk would retire and rest. There is not room enough inside for the animal. The head and tentacles, and the crescent-shaped foot protrude when the body is completely withdrawn. The colours of these fleshy parts rival those of the shell. In Mauritius the natives go out at low tide with net rakes to catch harps on the sands. The mollusk crawls rapidly along to escape the net. When hard pressed it withdraws as far as possible within its shell, and may cut off part of the foot by pressure upon the lips! This observation was made upon *H. ventricosa*.

The shell grows through a certain period, then ceases for a time. In preparation for this period of rest the lip is thickened. The strong ribs of the harp thus correspond to the varices of Murex and Triton. The shorter the food supply, the closer the ribs of the shell. The mode of feeding of these large mollusks

is a puzzle. The radula is of the olive type, but very much degraded. The central tooth only is left in each row.

The **Ventricose Harp** (*H. ventricosa*, Lam.) is swollen greatly in the middle; the most characteristic feature is the sharp angular compression of the broad ribs, ending in spinous processes that encircle the spire. Square spots of purplish red form broad spiral bands of dark colour on the paler brownish flesh-coloured ground. The interstices between the ribs are painted with bright festoons of light and dark brown. The bands show plainly in the wide aperture. The columella is widely reflected above and painted with brown blotches. Length, $2\frac{1}{2}$ to 5 inches.

Habitat.—Mauritius, Indian Ocean, Philippines.

The **Imperial Harp** (*H. imperialis*, Chemn., *H. costata*, Linn.) has a far greater number of ribs, and these are rounded and very closely set. There is no room between for the peculiar festooning pattern that traverses the grooves in the other species. The spiral bands of dark brown are narrower and more numerous than in *H. ventricosa*. The lining is bright orange as is also the reflected area of the columella. Length, 3 to 5 inches.

Habitat.—Mauritius.

The **Noble Harp** (*H. nobilis*, Lam.) is very distinct, its shell much contracted toward the base, the spire elevated, the ribs remote from each other, and painted with groups of fine black lines, forming dark spiral bands. The broad sulci are painted with curly lines of brown on a paler ground colour, or mottled with dark spots on a rosy ground. Sometimes the rose tint is restricted to large square spots. Length, 2 to 3 inches.

Habitat.—Indian Ocean, Philippines.

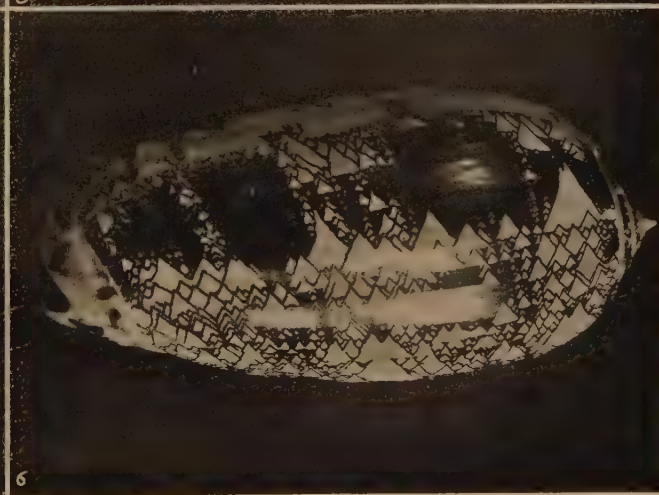
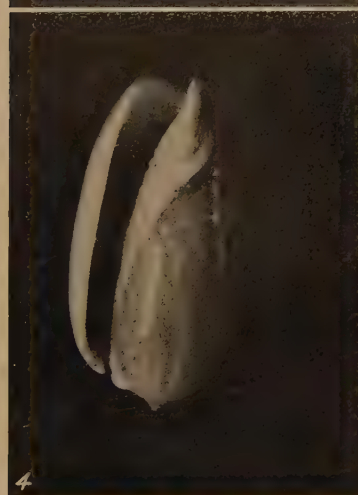
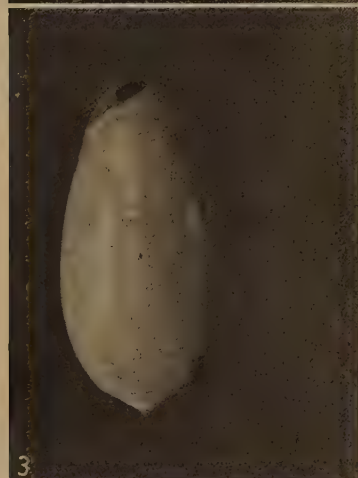
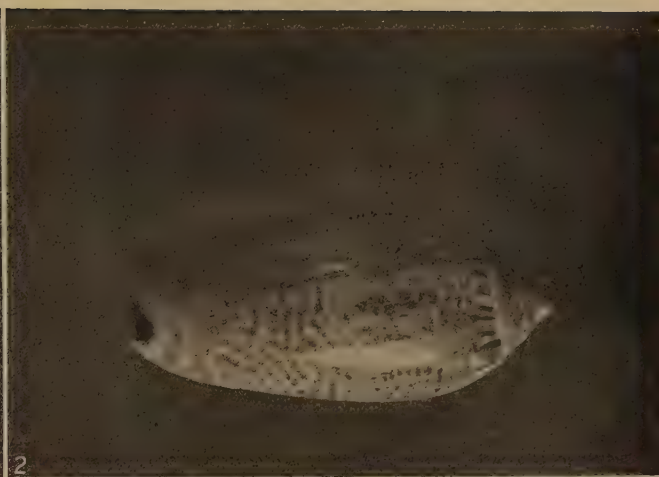
The **Rose Harp** (*H. rosea*, Lam.) is distinguished from its near relative, *H. nobilis*, by its delicate rosy colour, the faintness and irregularity of its flat ribs, and the absence of black cross lines. Length, 2 to 3 inches.

Habitat.—Senegal, Guinea.

The **Articulated Harp** (*H. articularis*, Lam.) is ventricose, thin and ashy gray, the distant ribs crossed by black spots or lines, sometimes grouped. Faint festoons of gray and yellow occupy about half of each wide interstice. Some forms are flushed with pink over the gray colour scheme. Length, 2 to 4 inches.

Habitat.—Pacific islands.

The **Crenated Harp** (*H. crenata*, Swains.) has a scalloped



OLIVE SHELLS

1. 2 Netted Olive, *Oliva reticularis*.

3. 4 Tiger Olive, *Oliva tigrina*.

5, 6 Camp Olive, *Oliva porphyria*.



MARINE UNIVALVES

- | | | |
|---|---|--|
| 1 Polished Ancillaria, <i>Ancillaria glabrata</i> . | 4 Southern Dove Shell, <i>Columbella mercatoria</i> . | 8 San Pedro Rice Shell, <i>Olivella Pedroana</i> . |
| 2 Cinnamon Ancillaria, <i>Ancillaria cinnamomea</i> . | 5, 6 Lettered Olive, <i>Oliva litterata</i> . | 9 Southern Rice Shell, <i>Olivella mutica</i> . |
| 3 Greater Dove Shell, <i>Columbella major</i> . | 7 Two-plaited Olive, <i>Oliva biplicata</i> . | 10, 11 Swollen Harp Shell, <i>Harpa ventricosa</i> . |

border, and the same wavy edge is shown by the ribs, and the undulating pattern that decorates the spaces between. The width of the ribs is usually unequal, but the greatest number of them are quite narrow; the crenations form a series of spinous tubercles. Colour, blue gray, festooned between ribs with black. Ribs, chestnut, banded on pale ground. Found in muddy sand in deep water. Length, 2 to 4 inches.

Habitat.—Panama.

The **Slender Harp** (*H. gracilis*, Brod. and Sby.) is least of all and slim, with flat ribs far apart, delicately semi-transparent, and tinted and variegated with gray and rose, accented with bright red hair lines. Length, $1\frac{1}{2}$ inches.

Habitat.—Polynesia.

The **Lesser Harp** (*H. minor*, Lam.) is slightly larger than *H. gracilis*, more square shouldered, decidedly darker. The narrow ribs are crossed with black lines in pairs. Wavy longitudinal markings of brown streak the spaces between ribs.

Habitat.—Indian Ocean.

The **Conoid Harp** (*H. conoidalis*, Lam.) is the most variable species. Its elevated spire and broad sloping shoulders, are constant characters. The ribs are narrow, rounded and distant. The colour scheme is brown in many shades, the pattern like the banding of an agate, crossing the ribs and festooning the interstices. Often the patterns are blurred, but the effect is very rich. Length, 3 to 4 inches.

Habitat.—Mauritius, Indian Ocean, Philippines.

CHAPTER XIV: THE DOVE SHELLS

FAMILY COLUMBELLIDÆ

SHELL solid, small, ovately oblong or triangular, sometimes fusiform; spire exserted; anterior canal short; columella arched, tubercled below; outer lip thickened, uncurved at middle, toothed on inner face; epidermis present; operculum horny; head long, eyes at base of tentacles, foot prolonged in front; mantle not enfolding shell. Radula present, degraded, behind the head. A family of few genera and many species. Little is known concerning the living mollusks. Their distribution extends into both warm and cold seas.

Genus COLUMBELLA, Lam.

Characters of the family. These handsome little mollusks crawl upon sand flats and on gravelly and rocky shores in the tropics and southward and northward to cold waters, in many parts of both hemispheres. There are upwards of eight hundred species named, but singularly, these have been erected upon shell characters chiefly; few of the living mollusks have even been seen, still fewer studied and figured. Lacking adequate knowledge, conchologists are throwing into the genus *Columbella* shells having the outer lip thickened and toothed on the inner edge. Study of the soft parts of various species will doubtless make radical changes in classification.

The **Common Columbella** (*C. mercatoria*, Linn.) lives in sand two to four feet below water level. The shell is solid, broad-shouldered, with strong revolving ridges crossed by faint longitudinal ones. The usual form is marked with streaks of brown and white across the whorls. Pink specimens occur, of plain colour or marked with fawn in irregular spots. In some forms yellow, in others chocolate prevail. The aperture is white or yellowish. Length, $\frac{1}{2}$ to 1 inch.

Habitat.—Florida and the West Indies.

The **Rusty Columbella** (*C. rustica*, Linn.), variable in form and colouring, is an ancient species, which in its broad forms resembles *C. mercatoria*. It is distinguishable by its smooth surface and by the purplish depressions between teeth within the lip. The markings are usually bright zigzag blotches or streaks of brown on a white or orange ground. Length, $\frac{1}{2}$ to 1 inch.

Habitat.—Mediterranean, West Indies and West Africa.

The **Lunar-marked Columbella** (*C. lunata*, Say) has crescents of chestnut crossing the paler ground colour of its whorls. The shell is fusiform, nearly smooth, with small aperture and lip faintly toothed. This minute mollusk is found abundantly. The animal is pale, the foot as long as the shell, the eyes black. In spring they are seen crawling on the sand in the shallows; their natural station is clinging to stones and seaweeds a few feet below the surface. Length, $\frac{1}{8}$ inch.

Habitat.—Cape Cod to Florida.

A number of species of small dove shells belong to the fauna of our west coast.

The **Keeled Columbella** (*C. carinata*, Hds.) is sometimes keeled, as its name implies, but sometimes not. The large northern shells, var. *gausapata*, are smooth, their tawny surfaces banded with brown and flecked with white. The outer lip is toothed within, and fairly thick. The typical *C. carinata* is not so long, with an abruptly angled shoulder on the body whorl. Var. *Californiana* is smaller and smooth, marked and coloured like var. *gausapata*. Length, $\frac{1}{8}$ to $\frac{3}{8}$ inch.

Habitat.—Sitka to Lower California.

The **Golden Columbella** (*C. aurantiaca*, Dall) is orange yellow, translucent, gracefully fusiform, with five rounded whorls. The teeth on the lip are scarcely visible. Sometimes the whorls are marked with zigzags of chestnut. Length, $\frac{1}{8}$ inch.

Habitat.—Monterey, Cal.

C. tuberosa, Carp., a little larger, with angled body whorls, varies from white to chocolate brown, from plain colour to spots, bands and zigzags of contrasting hues, as in var. *variegata*.

Habitat.—Santa Barbara and San Diego, Cal.

The **Rosy Columbella** (*C. rosacea*, Gld.) is striated, acutely cone-shaped, rosy white, but lacking teeth on the thin lip. This minute shell, $\frac{1}{8}$ inch long, occurs from New England to Spitzbergen and Norway. It is obtained from the stomachs of fish.

The Dove Shells

C. avara, Say, follows the Atlantic coast from Massachusetts to the west coast of Florida. It has a variable outline, and is nearly an inch long. The whorls are cancellated by intersecting striæ, the lower half of the body whorl, however, has only the revolving ridges. The yellowish ground is blotched with brown. The small aperture has teeth on both lips.

This mollusk lives below low-tide level, and is most abundant on southern coasts. In life the shell has a dirty, brown epidermis.

Genus AMPHISSA, H. and A. Ads.

Shell whelk-like, longitudinally grooved, apex elongated; aperture spreading to form a wide anterior sinus; inner lip callous with folds below; outer lip with fine plaits inside.

The **Wrinkled Amphissa** (*A. corrugata*, Rve.), yellowish brown, slenderly tapering, with fine ridges, occurs from California northward. Length, $\frac{3}{4}$ inch.

A. versicolor, Dall, shows a pleasing range of colours, from black and gray to red and yellow. It is a stout little mollusk, the sculpturing of whose shell is worth examining with a lens. It clings to rocks, and may be found exposed at low tide. Length, less than $\frac{1}{2}$ inch.

Habitat.—California.

The **Wavy Amphissa** (*A. undata*, Cpr.) resembles the preceding species in size and form, but there are remote wavy ridges crossing the fine spiral lines from apex to base.

Habitat.—In mud off Santa Catalina Island, Cal.

CHAPTER XV: THE CROSS-BARRED SHELLS

FAMILY CANCELLARIIDÆ

Genus CANCELLARIA, Lam.

SHELL spiral, cross-ribbed upon the whorls; aperture oblong, angulated or drawn out, bearing canal in front; columella with folds; outer lip ribbed; operculum wanting; foot broad in front; head bears tentacles with eyes at base; radula wanting; snout small. Vegetable feeders on tropical and temperate coasts. A single genus of seventy-seven living species.

The West Indian *C. reticulata*, Linn., is deeply cut by close cross ridges so that the surface is covered with coarse granulations. Occasionally the radiating ridges are wide apart and wavy. The colour is whitish with markings of brown bands or variegated patches. The columella has two sharp, strong plaits. The shell is heavy and ventricose. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.—Cape Hatteras to Florida.

C. Cooperi, Gabb, has an elongated spire, with the body whorl somewhat constricted above the long, oval aperture. To the very tip the spire is turreted and tuberculated, for the whorls have a distinct shoulder, and the longitudinal ridges form a sharp knob at every crossing. The whorls are elegantly marked with narrow, dark brown lines. The interior shows a series of ridges, and three basal, oblique plaits cross the columella. Length, 2 inches.

This handsome shell comes from deep water off the California coast. Fishermen drawing their nets have in many places learned that it is to their financial advantage to save all the strange shells they take with their fish. The conchologists have thus obtained some of their best treasures. Many unknowns have been brought to light by this means within recent years. When we consider how new our west coast is compared with the Atlantic seaboard, it is not surprising that more new forms are reported from that quarter. Most of the new specimens are sent by their

The Cross-barred Shells

owners to Dr. Dall at the United States National Museum in Washington, D. C. He has given names to them. The specimens thus for the first time christened by a scientist are the "types" of the new species. Specimens found later are compared with the type to determine what they are. "Types" are usually preserved in great museums.

C. cancellata, Linn., has a thick shell studded all over with sharp points left by the intersection of deep furrows crossing each other. Two bands of brown decorate the body whorl, one circles each whorl above. The ground colour is creamy white. The throat of the shell also has sharp ridges and teeth.

This ornamental shell is hidden in life by sand. The foot, unprotected by an operculum, has a sandy coat on the bottom, so that when it is pulled in the aperture seems to be plugged with sand. The species is found on sandy bottoms at four or five fathoms depth. The sand is no doubt a protection. The creature is slow and timid. It can extend the head and foot to surprising lengths. Length, 1 to $1\frac{1}{2}$ inches.

Habitat.— West Africa, Mediterranean Sea.

C. Stimpsonii. Calkins, is a colourless tropical species. Its whorls are angulated and noded, the surface below the shoulder decorated with rows of smaller projections. There are two plaits on the columella. The oval aperture ends in a short canal. Length, $\frac{3}{4}$ inch.

Habitat.— Cape Sable, Florida.

CHAPTER XVI: THE AUGER SHELLS

FAMILY TEREBRIDÆ

Genus **TEREBRA**, Brug.

SHELL heavy, long, taper-pointed, regularly spiral, of many flat whorls; aperture small, notched in front; columella without folds; operculum horny, annular; head large with eyes on tips of tentacles; foot round in front, elongated behind; radula present; proboscis large. A single genus of about 170 living and 25 fossil species. Inhabit shallow water in warm seas.

Few of the members of this tropical family are found in the cold waters of our coasts. These species are small and dull compared with the large and highly coloured species represented in museum collections. All have the characteristic tapering spire with many flat whorls. They are usually polished and mottled or banded with some shade of brown on a pale ground. Some are trimmed with nodules upon the whorls.

The **Variegated Auger Shell** (*T. variegata*, Gray) is streaked and spotted with brown on a whitish ground colour. A strong raised band revolves below each suture. The remaining part of the whorl is flat and finely striated. Fine wavy folds cross these striations. The raised bands bear prominent cross folds, between which are bright spots of brown. The body whorl has a central band of white dividing the cloudy brown cross streaks. The shell is polished, china-like and heavy. Length, $2\frac{1}{2}$ to $3\frac{1}{2}$ inches.

Habitat.—West Africa, China Sea, Galapagos Islands to Lower California.

The **Spotted Auger Shell** (*T. maculata*, Linn.) is a good type of the tropical members of the family. Heavy, solid, with many closely wound, flattened whorls winding down from a taper-pointed apex, it forms a needle cone of extreme elegance and mathematical exactness. The lower whorls are smooth, the upper ones longitudinally ridged. The ground colour is creamy white.

The Auger Shells

On it are wound two bands of coloured spots, the upper one of chestnut, the lower of purple or slate, with a dark line separating the two. The Polynesians fashion these shells into chisels for use in building their canoes. The flesh they eat. Length, 4 to 6 inches.

Habitat.— South Sea Islands.

T. dislocata, Say, is a grayish brown or yellowish white auger shell, 1 to 2 inches long, with surface sculptured by wavy longitudinal folds and fine spiral grooves. The whorl bears a raised, beaded band just below the suture. The columella has one distinct ridge.

Habitat.— North Carolina to West Indies.

T. protexta, Conrad, is very slender, with somewhat convex, finely striated whorls crossed by fine, sharp-edged longitudinal folds, set close together. It is china-like in texture, brown shading lighter. Length, 1 inch.

Habitat.— Gulf Coast of Florida to Cape Hatteras.

CHAPTER XVII: THE NOTCH-SIDE SHELLS

FAMILY PLEUROTOMIDÆ

Genus PLEUROTOMA, Lam.

SHELL spindle-shaped, with anterior canal of more or less length; aperture oval; lip thin, notched near the suture; operculum usually present, horny, annular; head broad; tentacles wide apart, with eyes at base; siphon long; mantle border notched below notch in shell; radula present; teeth long, hollow, connected with poison gland. A large family of little known shells found in all seas.

The spindle-shaped shell, drawn out at both extremities, has the tell-tale anal slit, or notch, in the outer lip near its junction with the spire. By this sign we know them. Some have the anterior canal short, but the spire is always elongated. Reeve lists 369 species. Many of these are described from single specimens, so the number is probably far too great.

The **Great Notch-side** (*P. grandis*, Gray), the largest species, is six inches long; its greatest diameter is about one inch. In this graceful spindle-shaped shell one sees the notch-sides at their best. The whorls are delicately chiselled in many sharp revolving ridges, with fine raised striæ between. Broken longitudinal and spiral lines of brown handsomely decorate the yellowish exterior. The finest and closest dots follow the sutures.

Habitat.—China Seas.

The **White Notch-side** (*P. Virgo*, Lam.) shows a glossy white surface where the horny epidermis is removed. Its whorls are deeply cut into ridges, the central one forming a strong keel. A series of these shells exhibits considerable variation. The spire is in every case longer than the canal. The name "White Tower of Babel," has been given this species. Length, 3 to 4 inches.

Habitat.—West Indies.

Carpenter's Notch-side (*P. Carpenteriana*, Gabb.) has a regular spindle shape, tapering gracefully to base and apex.

The Notch-side Shells

But it is not drawn out into needle-like extremities as some species are. Its whorls are flat, sculptured by revolving grooves and marked by brown lines that follow the strongest ridges. The ground colour is yellow, with a tinge of red. The notch is a mere sutural curve in the lip. The aperture widens below. Length, 2 to 3 inches.

Habitat.—California.

The **Left-handed Notch-side** (*P. perversa*, Gabb.) coils its ten or twelve rounded whorls so that the aperture is on the left side, contrary to the usual univalve rule. This is a slim little shell with very graceful curves, including a very decided S shape in the lip which forms a deep notch below the suture. Wavy longitudinal striations cross the whorl which are sculptured with fine spiral lines. The colour is reddish brown with an indistinct band of white in the middle of the whorl. Over all, in life, is a greenish gray epidermis. Length, 1 to 2 inches.

Habitat.—Southern California.

The **Tipsy Notch-side** (*P. vinosa*, Dall) is a shorter, stouter shell, with rounded whorls and deep sutures. It is sinistral and has a wide notch formed by the S-curved lip. Length, about 1 inch.

Habitat.—Aleutian Islands.

The **Girdled Notch-side** (*P. circinata*, Dall) is a well proportioned spindle shell, coiled dextrally; each whorl has a central raised girdle or keel. The lip flares outward to form the notch. Half the length of the shell is occupied by the large aperture. Length, 2 to 3 inches.

Habitat.—Behring Sea.

The **Unarmed Notch-side** (*P. inermis*, Hds.) represents a section of the genus distinguished by the slender spire, short curved canal, thick lip, and a sinus near (but not reaching) the suture. The pinkish gray exterior is cut by fine revolving ridges and cross grooves with a sharp angle at the middle of each whorl, giving it the appearance of "herring-bone" decoration. The colour shades deeper in the hollows. Length, $1\frac{3}{4}$ inches.

Habitat.—Southern California.

The **Carved Notch-side** (*P. incisa*, Carp.) is shaped like the preceding species, but smaller, with more convex whorls, and sculptured with fine revolving chestnut lines. It is a fraction over an inch in length.

Habitat.—Puget Sound.

P. mæsta, Cpr., is found on Southern and Lower California beaches under stones when the tide is out. Its brown shell is strongly cross-ribbed, with beaded and spotted sutures between the whorls. Length, about 1 inch.

P. torosa, Cpr., is cross-ribbed along the shoulder of the whorls, the protuberances contrasting with the brown ground colour. Length, over 1 inch.

Habitat.—Southern California.

Genus DRILLIA, Gray

Allied to *Pleurotoma*, and closely resembling it, but smaller and more delicately made throughout. Well represented on our west coast.

The **Pencilled Drillia** (*D. pencillata*, Cpr.) I first found alive on the sand at Terminal Island, below San Pedro harbour. It had been a notable day, for I found a large *Pomaulax* alive on the rocks at Dead Man's Island. The old jetty had yielded living *Pectens*, *Pteronoti*, *Olivellas*, bubble shells, and even a devil-fish of handy size to carry home. My good luck as a collector came from having as a guide Mrs. Oldroyd, whose wide knowledge of the molluscan life of the Pacific coast is recognised by all modern conchologists. She had her reward in the discovery of a rare species of *Thracia*, and in showing a stranger the rich fauna of San Pedro.

The train was late, and we returned to the beach, for the tide was at its ebb, and daylight still lingered. Well up on the sand we discovered little pellets of sand lifted. Under each was a *Drillia*, thrusting itself out of the narrow doorway, as if to survey the landscape. The slender spire, the notch, and the close, angled cross lines on each whorl, identified the species. The sutural notch produces the fine herring-bone pattern of brown and yellow that decorates the coils. The largest specimens were under two inches in length.

Habitat.—Southern California.

The **Knobbed Drillia** (*D. torosa*, Cpr.) is a northern species, much darker brown, with a pale beaded line following the suture. Length, 3 inches.

Habitat.—California northward.

D. mæsta, Cpr., like the last in size and form, substitutes

The Notch-side Shells

cross ribs for the beading of the suture. It is olive or brown, and dull. Look for it under stones as the tide goes out.

Habitat.—Southern California.

The **Burnt Drillia** (*D. empyrosia*, Dall) shades from yellow to dark brown, the colour deepening toward the latest whorls. The spire is stouter than that of its relatives. Across each whorl obtuse and pale knobs or ridges pass; the suture is outlined with white. The columella is arched decidedly at a point opposite the sutural notch. This species is dredged at some depth off San Pedro, and no shells are washed ashore. The largest are scarcely two inches long.

D. incisa, Cpr., ashy-hued, with revolving lines of red, resembles *D. pencillata*, but is half as large. Length, 1 inch.

Habitat.—Puget Sound.

The related genus, *Bela*, Gray, is a group of spindle shells usually notched, so we may recognise family traits in most of the species. Our dozen or more species are very small, and rare in collections, being for the most part Alaskan, many taken from deep water.

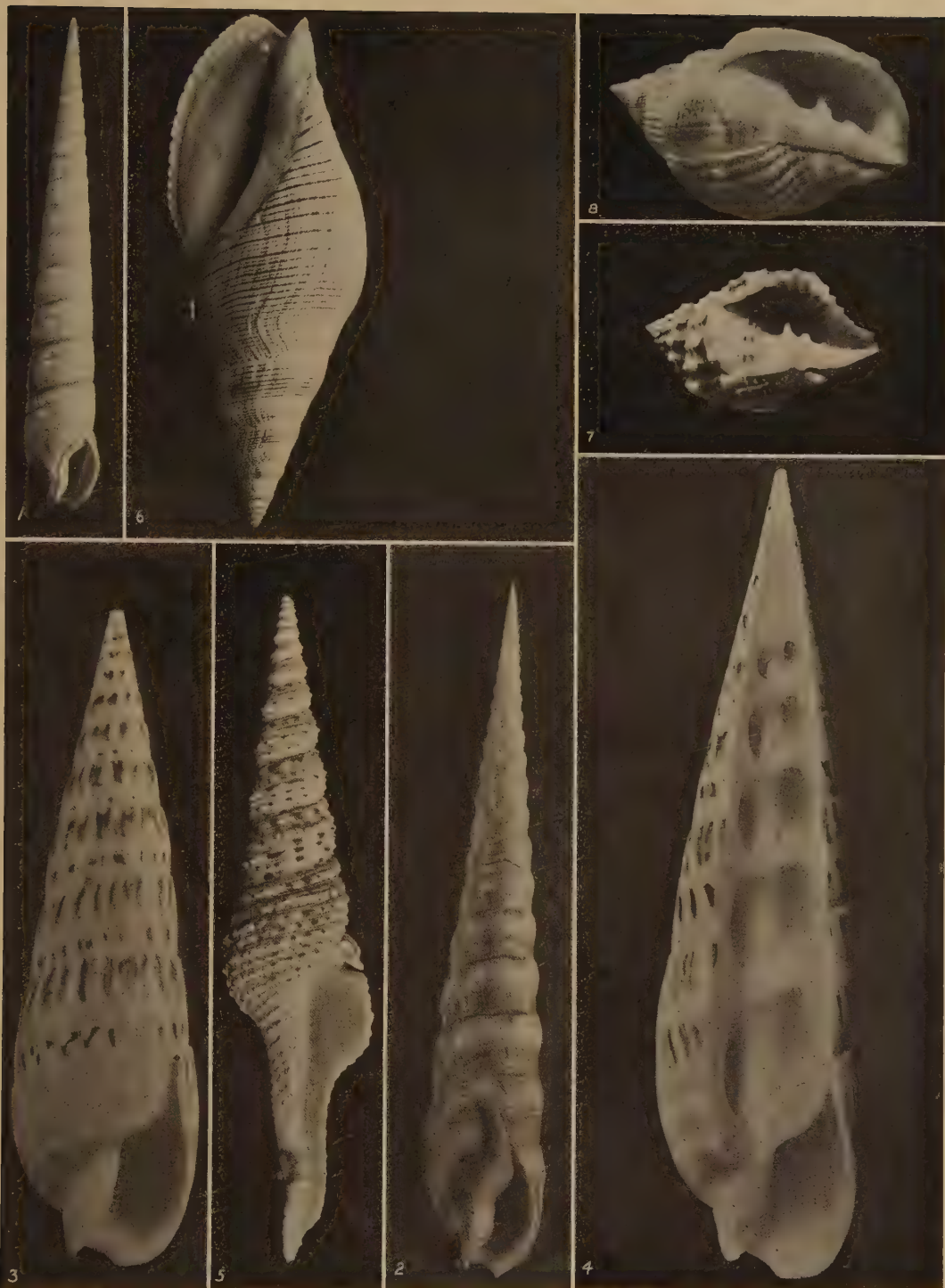
Genus MANGILIA, Risso

The spindle shape and narrow, long aperture characterise this group of a dozen west coast species. They are little, and rarely seen, for they are cold water forms for the most part.

M. merita, Gld., has six whorls crossed by distinct, rounded ribs, intersecting sharp spiral ridges. They are pure white. Length, $\frac{1}{2}$ inch.

M. variegata, Cpr., with still more prominent longitudinal ridges, is a thin, yellow shell, darkening toward the apex. The pattern is mixed and indistinct. Length, $\frac{1}{3}$ inch.

Habitat.—Southern California.



AUGER SHELLS

- 1 *Terebra cingulifera*.
2 *Terebra oculata*.

- 3 *Terebra maculata*.
4 *Terebra maculata*.

NOTCH SIDE SHELLS

- 5 *Pleurotoma grandis*.
6 *Pleurotoma carpenteria*.

CROSSBARRED SHELLS

- 7 *Cancellaria cancellata*.
8 *Cancellaria reticulata*.



A rocky beach where Periwinkles (*Littorina*) abound.

Queen Conch, *Strombus gigas*, of West Indies.

CHAPTER XVIII: THE CONE SHELLS

FAMILY CONIDÆ.

Genus CONUS, Linn.

SHELL heavy, porcellanous, inversely conical; spire broad, body whorl tapering to notched base; aperture long, narrow; lip thin, with sinus at suture; surface usually smooth, with striæ crossing the whorl, variously marked, under thin epidermis; operculum claw-shaped; head with snout enclosed in a long cylindrical veil, eyes on bases of tentacles; teeth set on a tubular prolongation of the proboscis; foot long, narrow; mantle enclosed, ending in anterior siphon. A single genus of over four hundred species, preying on other mollusks in tropical waters. Fossil species, one hundred.

This is one of the shell families it is easy to recognise at sight. The name defines the shape of the shell. Few of us will ever see the mollusks alive, but every alert collector may, and will, have specimens of the shells.

Both alive and dead, cone shells are handsome. We cannot imagine the wondrous beauty of tropical beaches. Fishes and all other creatures inhabiting the limpid water rival the birds and insects in brilliance of colouring and grace of motion. No more beautiful forms and colours are found in the flowers and foliage of tropical plants than are matched among the seaweeds and gorgonias and sea anemones that form the groves among coral reefs.

The cones do their share to make the coral groves beautiful as fairy land. They are favourites with collectors, holding their own with cowries and other high-priced shells. Some species are not only beautiful but rare, a combination of characters which in the case of the "glory of the sea" (*C. gloria-maris*) has run the price at auctions to £43 sterling, and keeps it up even now near the high water mark of shell prices. Six specimens

of five different species of *Conus* sold at auction in 1865 averaged over £20 (\$100) apiece.

The white cones are in great demand in the islands of the Pacific, especially large individuals, cross sections of which are polished and worn as armlets by native women. Small white cones are strung into necklaces. European dealers do a large business in these shells, charging the islanders high prices for them. Other rare species of shells native to inland waters have sometimes been discovered in necklaces which sailors have obtained in exchange for cheap trinkets that pleased aboriginal eye.

From accounts we have from naturalists who have made the acquaintance of the large cones on tropical beaches we might infer that they are vicious in temper, striking at the hand that ventures to pick them up, and dealing death with the stroke. This is the cone at bay, and afraid for his own safety. The same writers tell us that these mollusks are timid and not bold; they move slowly; when disturbed they retire into holes in the rocks. Their food is chiefly bivalve mollusks whose shells are bored through by the circular toothed tip of the snout. The juices of the body are sucked through the opening.

The cones deposit their eggs in flat, leaf-like capsules, set in rows on edge, on the surface of dead shells and like objects. A band of thin but tough membrane holds them together and fast to the shell. The young escape through a hole in the outer margin of the capsule. The shells of cones are usually large and thick, though some species are as small as a grain of rice. The absorption of the substance of the internal subdivisions of the spire goes on until they become very thin. This adds to the store of building material available for thickening the outer shell. It also gives more room for the body as it grows larger.

If I should undertake to describe all the four hundred and more species which are assigned to this genus the equilibrium of this book would be entirely destroyed. Anyone who has a cone in his collection can recognise it by the family characters. I shall describe a few of the most striking species, the largest one, the handsomest, the highest priced, the most venomous and the most common cabinet species, before going on with the descriptions of the few native species, none of which is omitted.

The **Promethean Cone** (*C. Prometheus*, Hwass), is the giant, occasionally measuring nine inches in length, though this is far

above the average. As cones go, this is unusually thin for its size. The spire is rounded but very low; the sutures are channeled. Each whorl has an angled shoulder next to the suture. The surface is white overlaid with cloudy bands made of small dots and patches and zigzags of brownish yellow.

Habitat.—East Africa.

The **Rhododendron Cone** (*C. rhododendron*, Jay) borrows its colour from the flowering shrub familiar to many in parks and gardens. It does not abandon brown altogether, but subordinates it to the broad mottled bands of bluish rose colour. The white areas between have fine brown dots sprinkled over them, and brown stains overlie the rose-colour to a varying extent. The china-like shell is deeply grooved upon the flat spire, below the sharp angle of the body whorl, and on its lower half. The middle portion is smooth.

This Australasian species averages about two inches in length. Tryon thinks it "perhaps the most beautiful species in the genus." To be positive on this question is impossible.

The **Glory of the Sea** (*C. gloria-maris*, Hwass) is a cone of unusual slenderness, with a high-peaked spire. It is magnificent in finely reticulated orange brown lines, enclosing triangular spaces. Over this network are three unequal bands of deep chestnut, made of small blotches set in somewhat regular order. The length of this species ranges from three to five inches. This is a very rare and highly prized species.

Habitat.—Philippines.

Hugh Cuming, the great English shell collector, loved to tell of his varied and thrilling experiences in the Pacific Islands. The most wonderful event of his life occurred on the Philippine Island of Juena. He was out on a coral reef. Casually turning over a stone he saw three living specimens of the rare and costly *gloria-maris* before his eyes. "I almost fainted with delight!" he exclaimed in recounting the event. But he did n't. Two were young ones, the third an adult. They are now safe in cabinets; every collector of cones knows just where, and just how rich he ought to be if he hopes ever to buy one.

Cuming made his unexampled "find" in 1838. In a short time an earthquake shook that reef into the sea. There have been no more cones of the coveted species found in that region. Indeed, the whole number known to conchologists is less than a

The Cone Shells

dozen. Most of these are in museums, and are not likely to change hands. I note in the *Nautilus* of October, 1890, that a specimen secured by a collector in Europe is valued by him at \$500. Mrs. Constable of New York has a fine specimen in the admirable conchological collection made by her late husband. The species is practically extinct.

Though no American museum can show a shell of this species, many libraries have Reeve's "Conchologia Iconica." A fine colour plate of a *gloria-maris*, life size, forms the frontispiece of the first volume.

The **Cloth-of-gold Cone** (*C. textile*, Linn.) is stout and heavy, with low-peaked spire. The exterior is covered with longitudinal zigzag lines of dark brown and yellowish blotches arranged to form three broken bands of darker colour on a white ground, divided by brown lines into triangular patches. Altogether the resemblance to some intricate brocaded fabric is striking, and the name is well chosen.

The virulence of the poison of this species is vouched for by good authority. Deaths by gangrene following bites of this species are known to occur. The natives of the South Seas declare that the mollusk spits the poison several inches. Length, 2 to 4 inches.

Habitat.—Red Sea, Ceylon, Australasia.

The **Lettered Cone** (*C. literatus*, Linn.) bears row after row of oblong brown characters on its white surface. A yellow under-colour groups these rows into indistinct bands. The spire is flat and in adult shells roughly calcareous and colourless, as if the peak had been ground off and not polished. This is one of the commonest and most striking of the cones. Length, 3 to 6 inches.

Habitat.—East Indies.

The **Thousand-dotted Cone** (variety *millepunctatus* of the species above) has the same characters except that the dots are much smaller and more numerous.

The heaviest and stoutest of the cone shells is **C. betulinus**, Linn. In life it is covered with a thick, reticulated brown coat. Under this the smooth porcellanous substance is yellow, finely cross-banded with rows of dark brown dots. Three or four strong varices occur on the body whorl. The spire is scarcely elevated. Length, 3 to 6 inches; breadth of shoulder, 2 to 4 inches.

Habitat.—East Africa to Philippines.

The **Virgin Cone** (*C. virgo*, Linn.) is striking in its lack of colour markings so characteristic of the family. The heavy shell is yellowish white with violet stain on the basal part. Fine striations cover the surface. Polished specimens have a white china-like, artificial appearance, but they still preserve the violet colouring. Length, $2\frac{1}{2}$ to 4 inches.

Habitat.—Red Sea to Australia.

The **Marbled Cone** (*C. marmoreus*, Linn.), commonly seen in collections, is strongly marked with large white creamy spots, mostly triangular, separated by bands of dark brown. It is one of the showiest species in the genus. The spire is low and blunt, its sutures concave, its ridges set with tubercles. The ground colour outside and within the aperture has a pink flush. The pattern and proportion of colour varies in this species, which gives rise to a few distinct varieties. The typical form is a good-sized shell, quite heavy, about "half and half" dark and light, in colours and pattern described above. Intermediate gradations unite all the varieties. The bite of this species is much to be dreaded, as the barbed teeth are charged with venom and inflict severe wounds. Length, 4 to 5 inches.

Habitat.—China Seas.

The **Court Cone** (*C. aulicus*, Linn.) has a narrow shell tapering to its spire without a distinct shoulder — imitating the olive shells in form, rather than the cones. Its brown surface is bright with triangular white spots arranged without definite order. Fine raised lines groove the surface. This is the East Indian species which Arthur Adams describes as possessing a beautiful mottled red and white proboscis. It is a defensive organ as well. This writer saw a specimen strike the hand that took it from the water, inflicting a deep triangular wound with the sharp teeth that rim the cylindrical tongue. It was a poisoned bite, too, that burned and swelled angrily and gave acute pain, but healed after forming a watery blister. Length, 3 to 5 inches.

Habitat.—East Indies.

Several tropical species have reputations for venomous bites likely to prove serious. Examination of a single tooth shows it to have a hollow tube running from tip to poison gland as in the fang of a serpent or a spider. Besides, it has a sharp, backward-pointing barb below the tip. The South Pacific Islanders know which are the most dangerous species. "A native of the

The Cone Shells

Island of Matupi, New Britain, who had been bitten by a *Conus geographus* at once cut small incisions with a sharp stone all over his arm and shoulder. The blood flowed freely, and the native explained that if he had not taken these precautions he would have died."—*Cooke*.

The **California Cone** (*C. Californicus*, Hds.) is a plain little colourless shell when the cinnamon-brown epidermis wears off. The largest is less than two inches long. The spire rounds up to the elevated peak. The body whorl is rather square-shouldered. There are occasionally cloudings of pale chestnut on the spire and about the base of the shell. Southern California.

The **Florida Cone** (*C. Floridanus*, Gabb.) has a low but very steep spire and a squarish keeled shoulder whorl. The yellow ground is streaked with broken lines of brown spots grouped so as to leave bands of white between. Single rows of dots are often seen on the lower part of the body whorl. Length, 1 to 2½ inches.

Children on the Florida beaches call these much admired shells "Chinese tops." The serried dots look much like the characters of some unknown alphabet, and the perfect cone shape and sharp little apex suggest spinning capabilities.

Habitat.—Florida.

The **Protean Cone** (*C. Proteus*, Hwass) varies, as its name suggests, in colour and markings. It is a square-shouldered cone with a sharp apex, with its white surface darkened by splotches of brown arranged in spiral bands, often interrupted, and painted with longitudinal white streaks. A single broad canal occurs on the depressed spire. Length, 1 to 3 inches.

Habitat.—West Indies, Florida.

The **Mouse Cone** (*C. mus*, Hwass) has a high turbinated spire set with white tubercles and the body whorl with raised spiral striæ. Broken streaks of chestnut cross the whorls; a white spiral band often occurs in the middle of the body whorl. Clouding of blue often underlies the striping, just below the angled shoulder. Olive stains may occur near the base. Length, 1 to 2 inches. West Indies, Florida.

Peale's Cone (*C. Pealii*, Green) has an unusually steep spire and strong grooves on the lower half of the body whorl. The yellowish ground is spotted with brown and white dots in spiral lines. Length, 1 inch. Bahamas, Florida.

CHAPTER XIX: THE CONCH SHELLS

FAMILY STROMBIDÆ

SHELL heavy, porcellanous, with conical spire; aperture elongated, channeled at both ends; outer lip generally thickened and dilated; curved sinus for the head near basal canal; operculum claw-like, horny, notched on edge; foot narrow in front, arched and broad behind; head with contractile snout, highly developed eyes' tentacles rising from stout eye-stalks; radula well developed; siphon short.

Active, intelligent mollusks, chiefly carrion-feeders, found on reefs in tropical seas. Shells used in manufacture of porcelain and lime, in cameo-cutting and for ornament. Animal sometimes eaten.

THE TYPICAL CONCHS

Genus STROMBUS, Linn.

Shell ovate, solid, usually tubercled, lip dilated only when full grown, polished within. About sixty-five species, chiefly of large size, represented in Florida by a few West Indian species.

The **Queen Conch** (*S. gigas*, Linn.) is the largest mollusk native to any part of this country. It ranks with the giant shells anywhere, indeed, for it occasionally measures a foot in length, and attains a weight of five pounds. Moreover, it is a handsome shell, for its horny, rough exterior has polished rosy lips and lining. Valuable pink pearls are sometimes found within the mantle folds, though they are but semi-precious, being china-like in texture rather than pearly.

The pink outer layer of the lip has a white foundation, and is used by cameo-cutters. Shells which give greater colour contrast between the raised figure and its background are preferred in the cameo trade. The pink fades by exposure to light in both pearls and cameos. In spite of these faults conch shells are much used.

The Conch Shells

Quantities are shipped yearly to Liverpool and other cities to manufacturers of porcelain. Ground to powder, they are especially adapted to this use.

Though it lives only in tropical waters I fancy the conch is pretty well known all over the country. People call it by its name, and are always glad to have specimens. They are a common ornament on mantels, and most shell fanciers have them. The first one I ever saw came from the grocer. He had several barrels of them, and presented one to each purchaser of a quarter's worth of a new brand of laundry soap! Few who live near the ocean can realise what a profound sensation this shrewd advertising device created among the prairie folk whose largest and most beautiful native mollusk is the dingy, but pearly-lined river clam.

In Florida these giants clamber over the coral reefs, and in still greater number along the coasts of the West Indian isles. The "fountain shell" is a popular name, though I do not know why. You may see the bare walks and flower beds outlined by rows of weather worn and ugly conch shells in many southern cottage gardens, and conch shell hanging-baskets overflowing with trailing vines suspended in windows and from the lower limbs of trees. The dinner horn on the plantation is often a conch with its spire sawed off. The welcome "shell blow" calls the West Indian Negroes from the sugar cane fields at noon. I have seen these conchs also on Iowa farms and on ranches in Wyoming serving the same purpose. The ancient inhabitants of the islands made various rude weapons and utensils from this overabundant shell. These have been unearthed from shell mounds in Florida and elsewhere.

Alive among its coral rocks the conch is master of the situation. The shell is massive, but the animal is strong enough to carry it without inconvenience. The muscular body thrusts out the arching foot, which extends forward a thumb-like process, the foot proper, with a creeping disk scarcely larger than a thumb nail. The enlarged hind portion of the foot bears the claw-like operculum on its extremity.

The peculiar foot gives rise to a peculiar gait. The conch is impulsive in temperament. It does not glide, but jumps along, striking the sharp claw into the sand, and flopping the shell from side to side as it proceeds. A most astonishing sight is a frightened conch taking long leaps, and making quick turns to escape capture



CONE SHELLS AND A CONCH SHELL

- 1 California Cone, *Conus Californicus*.
- 2 Marbled Cone Shell, *Conus marmoratus*.
- 3 Fighting Conch Shell, *Strombus pugilis*.
- 4 Lettered Cone Shell, *Conus literatus*.
- 5 Virgin Cone Shell, *Conus virgo*, showing absorption of inner coils of spire.



BEAK SHELL AND CONCH SHELLS

1 *Rostellaria fusus*

2 *Strombus auris-Dianæ*

3 *Strombus Peruvianus*

4 *Strombus costatus*

when pursued. If placed on its back, it rights itself by a somersault. A downward slope is a great advantage, for here the weight of the shell becomes a propulsive force, and the foot is kept busy lifting the shell into positions of unstable equilibrium, when a slight push of the operculum sends it rolling down hill. This is convenient in getting back to the water after being stranded on the beach.

The giant conch is the scavenger of our tropical beaches; it is believed to subsist wholly on carrion. The sense of smell is as keen as the remarkable eyesight. Dead fish and other animal refuse attract great numbers to the spot where it is placed.

These creatures are easily captured with a bait of meat. In turn they are used as food by part of the population of the Bahamas, and at Key West. Indeed, the inhabitants are called "conchs" in mild contempt by Floridians and others whose taste in shell fish does not include this "buzzard" mollusk.

The **Goliath Conch** (*S. Goliath*, Chemn.), a rare West Indian species, is 8 to 10 inches long; its lip is spread to unusual length and breadth, forming a great wing. The aperture is lined with orange brown. The spire is banded with double grooves, and knobbed with blunt tubercles above.

The **Fighting Conch** (*S. pugilis*, Linn.), 3 to 4 inches long when full grown, is very common on the Florida coast, east and west. The spire is tapering, the whorls sculptured with fine parallel revolving grooves, the upper margin of each whorl set with sharp knobs. The aperture has an anterior and a posterior canal and a notch for the head in the broad outer lip near the tapering base of the shell. Outside, the pale colour of the shell is clouded with brown in bands or patches, often purplish, darkening on the body whorl. The shell lining is polished, as is also the columella. The lip is orange or deep red, shading back to purple, finally to pink.

The species exhibits considerable variability. Forms lacking the knobs on the shells have been described as a distinct species, *alatus*. Intermediate forms unite this smooth-shelled form as a variety to the species *pugilis*.

It is an exciting experience to watch these conchs on a Florida beach contriving to get back to the water after being

stranded by the tide. One rarely sees in Florida such an illustration of strenuousness. The extended hook is struck into the wet sand, and over the shell rolls; the second stroke flings it in another direction. You can see the radula working rapidly as the proboscis is lifted. Obstacles are avoided, corners are turned, wherever possible the conch makes a leap, and at last plunks joyfully into the water. Not seldom does a handsome specimen escape the amazed collector by jumping out of the boat.

This handsome "molluscan buzzard," with all its pugnacity, accommodates within its shell a little crab, named by Miss Rathbun, *Pinnotheres strombi*. Perfect amity seems to exist between them. The mutual advantage of this arrangement is not quite clear to me.

It is possible for northern aquariums to have fighting conchs as tenants. Live specimens have been shipped to Philadelphia in no better wrappings than newspaper, surviving the long journey to be studied for months in a jar of sea water. It is true, however, that the exiles refuse food. At least this is the experience of one student. He made every effort to supply them.

The **Hawk Wing Conch** (*S. costatus*, Gmel.), found in the West Indies, is 5 to 6 inches long, a heavy ovate shell whose short sharp-pointed spire is decorated on all its whorls with blunt knobs, those on the body whorl very large. The lip is thick and dilated, tapering at both ends. The lining is white or reddish. It requires some effort to see the resemblance to a hawk's wing in the expanded lip of this shell.

The **Angel Wing Conch** (*S. gallus*, Linn.), 4 to 6 inches long, has a long, channeled finger considerably higher than the elongated, knobbed spire. The shell has a long curved basal stem and the lip flares widely. The exterior is ridged spirally and marked with blotches of orange brown. The aperture is tinged with the same colour. *S. auris-Dianæ* has a similar form.

Habitat.—Red Sea.

The other species range from the size of a cocoanut to less than an inch long. They vary from the stout ovate shape of average conchs to slender spindle shape on one hand and typical cone shape on the other. High colouring is com-

mon. All tropical seas have their representatives. Yet the largest, finest and most prolific species of the genus live in the West Indies.

THE SCORPION SHELLS. SPIDER SHELLS

Genus **PTEROCERA**, Lam.

Shell spiral, oval, heavy, the outer lip prolonged into long finger-like processes. Animal like *Strombus*. Ten species.

Our American coasts have no representatives of this striking group. They are sociable, shore-loving mollusks, closely allied to *Strombus*. Where our genus exaggerates the outer lip into an unnecessary wing, these species use an equal amount of material in the long, curved fingers that make the mollusks look like great spiders or scorpions, travelling upon six or eight legs. The young have plain-lipped shells until quite well grown. Then the points grow out as hollow canals containing filaments from the mantle margin. Ultimately they become solid. The surface bears strong knobs and ridges, and the smooth, polished aperture has a pink or orange lining. Tropical seas of the eastern hemisphere.

P. bryonia, Chemn., from the Society Islands, is the largest species. The description above just fits it. The specimens approach a foot in length. Ponderous and coarse outside, the wide aperture reveals an expanse of fawn-coloured enamel tinged with pink that is truly beautiful.

THE LITTLE BEAK SHELLS

Genus **ROSTELLARIA**, Lam.

Shell spindle-shaped, with elevated spire of many smooth whorls, the last prolonged into a slender anterior canal; posterior canal extends from the top of the aperture, outer lip thickened, dilated, set with teeth; operculum not saw-toothed. Animals similar to *Strombus* in structure and habits, though usually timid and suspicious, whereas the conchs are bold. They inhabit the China Sea, the Red Sea and the Philippine region, in deep water. Tryon describes ten species. Type, *R. curta*, Sby.

The comparative variability of certain of these shells has

The Conch Shells

made a strong demand for them among collectors. A little one, *R. powisii*, Petit, rare but by no means the most beautiful species, brought 200 francs at a sale in 1877.

R. fusus, Linn., with the most graceful spindle shape, is the prize of the genus. It has a stem as long as its spire and six short teeth on the outer lip. Length, 6 to 8 inches.

Habitat.—China.

THE LITTLE SCREW SHELL

Genus *TEREBELLUM*, Lam.

Shell slenderly conical, china-like, spire blunt; aperture narrow, notched; lip sharp, simple; columella straight, truncate; one eye pedicel very long, protruded through the anterior notch in the shell.

T. subulatum, Lam., is a dainty "lady finger" in form and size. Nothing but structural characters of the fleshy parts suggest its relationship with the strombs. It is well described above. The polished white surface is daintily mottled with brown. The body whorl is four-fifths of the total length. It looks more like a slim little olive shell than anything else.

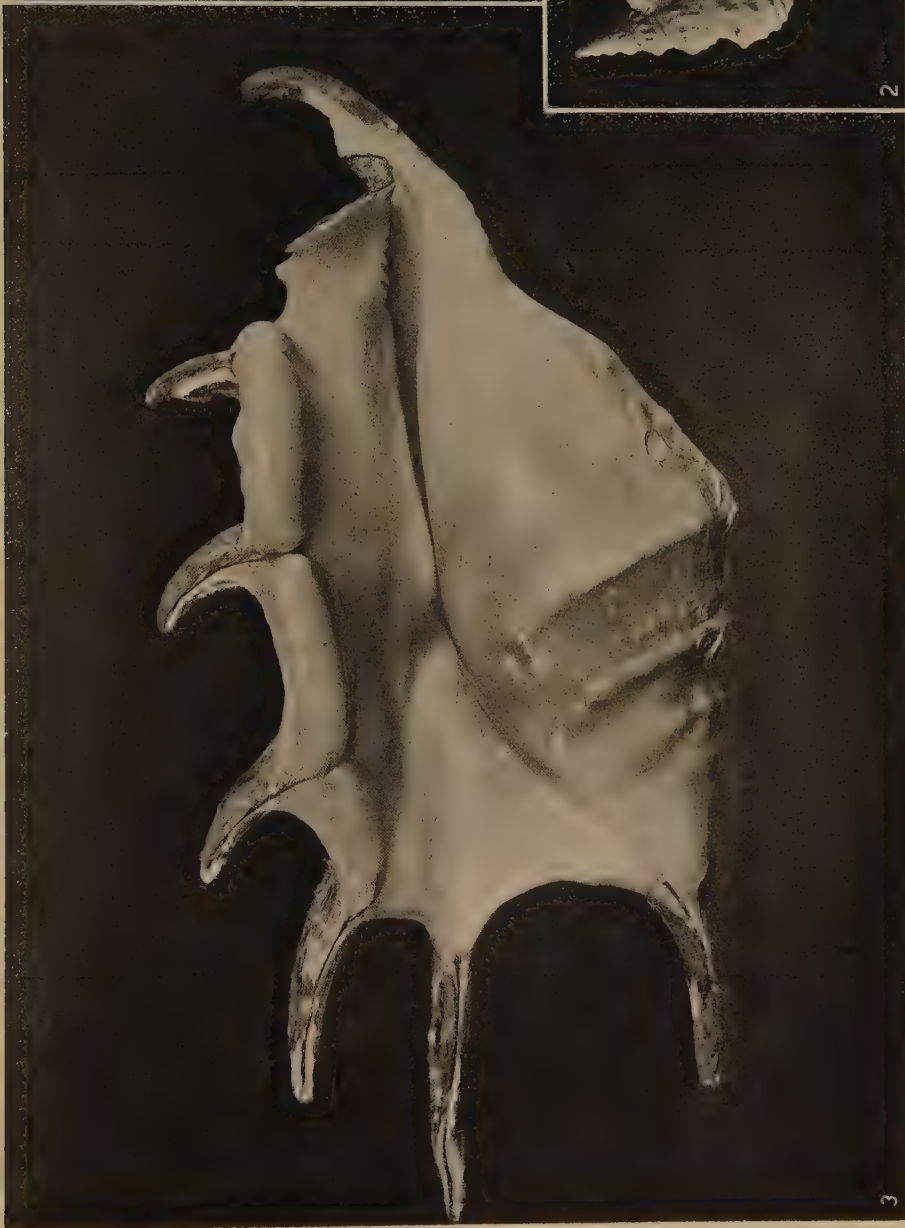
The creature is shy and sensitive to disturbance. While taking observations it is a strange-looking object, with its one eye thrust out so far, and waving about, while the pointed shell is held unsteadily in a vertical position. It takes fright easily and moves by a series of quick jumps. On one occasion a beautiful specimen leaped suddenly out of the hand of Mr. Hugh Cuming, the eminent English collector, as he was admiring it and congratulating himself upon getting one alive. Length, 2 inches.

Habitat.—China, Philippine Islands.

THE PELICAN'S FOOT

Genus *APORRHAÏS*, Dillw.

Shell spiral with whorls angled and set with knobs; outer lip much expanded, ending in two to three flattened fingers, as



1 Little Screw Shell, *Terebellum subulatum*.

2 Pelican's Foot, *Aporrhais pes-pellicani*.



3 Scorpion Shell, *Pterocera lamissi*.



COWRIES

1, 2, 3 Money Cowry, *Cypræa moneta*.

4, 5 Nut-brown Cowry, *Cypræa spadicea*.

6 Measled Cowry, *Cypræa exanthema*, showing pointed spire and flaring lips in young shell.

7 Eyed Cowry, *Cypræa Argus*.

8 *Cypræa spurca*.

long as the shell proper; posterior and anterior canal prominent. Four species in the North Atlantic.

The **Pelican's Foot** (*A. pes-pellicani*, Lam.) is a strange-looking customer. The four webbed toes of a pelican's foot are certainly suggested by the modifications of this shell's outer lip. The toes and thin webs extend backward, covering a considerable portion of the body whorl of the shell.

This mollusk is slow and awkward in movement, throwing out its foot and twisting its neck in its efforts to get along. Its forked shell lip is formed late in life, after which it merely becomes thicker. By counting the layers, it is believed, one may determine the age of the individual. The flesh is eaten by the poorer classes in Venice. In Edinburgh it is called the "blobber-lipt whilk."

This peculiar shell is likely to occur in any collection. It is yellowish brown. Length, about 2 inches.

Habitat.— European seas.

A. occidentalis, Beck, the western species, is known so far by its shell alone. Fish pick up the living mollusks in deep water off the Newfoundland Banks, and the shells are taken from their stomachs afterward. Imperfect specimens are washed ashore on Newfoundland beaches. The spire is closely ribbed both ways, and the outer lip expands into a wide, three-cornered, concave wing. Knowledge of the animal may eventually take this shell out of the genus to which it is now tentatively assigned.

THE OSTRICH-FOOT SHELL

Genus **STRUTHIOLARIA**, Lam.

Shell oval oblong, spire turreted, whorls with angled, knobbed shoulder; aperture roundish, narrowed by the thickening and flattening of both lips; operculum short, claw-like, with apical projection.

This New Zealand genus, containing three or four species, is allied with *Strombus* and *Rostellaria*. The form of the aperture and operculum account for the name. Length, 2 to 3 inches. Type, *S. nodulosa*, Mart.

CHAPTER XX: THE COWRIES. VENUS SHELLS

FAMILY CYPRÆIDÆ

SHELL solid, oval, or pear-shaped, ventricose, highly polished and handsomely coloured; spire covered by body whorl in adults; aperture long, narrow, ending in two short canals, both lips toothed; operculum wanting; animal large, highly coloured; mantle two-lobed, reflected over the shell, its surface warty, variously coloured; foot large, simple, oblong, with marginal folds; usually coloured; siphon broad, short, often fringed; head cylindrical, blunt, with long tentacles bearing eyes; radula long, well developed; jaw horny.

A large family of shy, slow-moving mollusks in warm seas, feeding on coral polyps. The shells are among the most beautiful and most highly prized. It is believed by children in many lands that the sound of their native sea is imprisoned in these shells.

Shake one, and it awakens; then apply
Its polished lip to your attentive ear,
And it remembers its august abode
And murmurs as the ocean murmurs there.

—*Walter Savage Landor.*

Genus CYPRÆA, Linn.

Characters of the family. A large genus of good-sized mollusks, highly coloured and richly ornamented in body and shell. Weinkauff describes 189 living and 97 fossil species.

Three cowries live on our Florida coast, another belongs to Southern California. From these northern representatives of a tropical genus we get but a faint notion of the wonderful richness of colour and pattern to be seen in the nearly two hundred distinct species and their varietal forms which the ardent collector assembles from tropical and sub-tropical coasts. The handsomest shell is not so handsome as the living animal that inhabits it, engulfing the shell completely as it glides along in mantle folds

tufted with brilliantly coloured, branching, coral-like outgrowths, and numerous spots of contrasting hues. Beneath is the thick, richly coloured foot on which the creature glides with dignity and grace over the rocks, below the level of the lowest tide.

"What daring is exhibited," we naturally exclaim, "by this proud aristocrat of the mollusk world, which exposes itself to countless dangers by such superlative ornamentation! How much wiser is the humble periwinkle of colder coasts, which puts on colours to match the slimy mud it lives in."

Remember that tropical shores are unlike ours, even as tropical birds and flowers and fruits make ours seem tame and colourless. The traveller who has looked through the glass bottom of a Bermuda or a Santa Catalina boat, or gazed through a water glass on the painted fish and the brilliant coral groves in the harbour of Nassau needs no hint from me of the riot of colour, and wealth of ornamentation lavished by nature upon the sea beaches where the coral polyps, the gorgonias and the cowries flourish. The poet Percival must have looked upon that enchanting scene or he could not have written, in "The Coral Grove"

The floor is of sand, like the mountain drift,
And pearl shells spangle the flinty snow;
From coral reefs the sea plants lift
Their heads where the tides, and billows flow.

There, with a light and easy motion,
The fan-coral sweeps through the clear, deep sea,
And the purple and scarlet tufts of ocean
Are bending like corn on the upland lea;

And life in rare and beautiful forms
Is sporting amid those bowers of stone,
And is safe when the wrathful spirit of storms
Has made the top of the waves his own.

The cowries exhibit protective coloration just as the gorgeous tropic birds do in the blossoming silvas.

The problem of the cowry shell's development has always puzzled conchologists. Few scientific observers have had any evidence to submit, so speculation has helped on the controversial discussion. Because a series of shells of any well-known species shows considerable difference in size, some argued that the mollusk

dissolves its shell when it becomes too tight a fit, and secretes a new one of larger size.

Reeve quotes a letter from Lieutenant Hankey of the Royal Navy, written in 1844, in which this gentleman declared that he had seen more than one specimen crawl away into a sheltered hollow, where the shell, enveloped in the mantle lobes, became thinner and dull in colour and finally cracked, by muscular force exerted within. Next the solvent completed its work, leaving a naked mollusk, which soon secreted a transparent, glutinous shell, with a distinct spire and wide lip (the Cymbium shape of all juvenile cowry shells), which rapidly took on thickness, covered the spire, narrowed the aperture, thickened and toothed the two lips and painted the various layers of enamel according to the specific pattern.

His reasons for not collecting a series of these remarkable shells in process of reconstruction were: (1) the extreme rarity of the occurrence described; and (2) the extreme fragility of the shell in its transparent state. It went into bits as if made of shellac when taken up.

Reeve politely discredits much of the account, as do subsequent authorities. However, it is generally accepted that the inside of the shell, down to the lips, is gradually dissolved as the exterior is added to; by this means room is gained for the growing body. The shell is made largely of carbonate of lime, a substance easily soluble by an acid secretion. It is believed that this process is periodic, occurring but two or three times; and that the readjustment is accomplished in retirement and in a very short time.

Differences in size of adult shells of one species are believed to be individual. The stage of development of a shell may be roughly estimated by the shape, size, colour and pattern. *Cypræa exanthema* is typical. The young mollusk has a thin bulla-shaped shell, with wide aperture, and prominent spire. The surface is banded with flame-like streaks of brown. Gradually the lip thickens on the side next to the aperture, while the back and sides receive layers from the mantle edge which bury the coils of the spire completely. Lip and columella grow closer together and become toothed. Coloured layers alternate with thin coats of white enamel. The final layer of colour is in bright spots and the bands are faintly seen under the pale ground colour.

The enamel is much more brilliant than on any former layer, the final polish being the last constructive effort of the mantle.

Cowries are used for personal adornment among uncivilised tribes. Overlapping rows of small ones cover the skin jackets worn in Borneo. The harness of elephants and horses in India are trimmed with cowry bands. Strung as beads, or sewed like buttons on clothing they satisfy the primitive craving for personal decoration in many regions. Among civilised people, in whom the same instinct persists, the small blue-backed money cowry is often seen joined in bracelets, each shell with a little cameo figure cut in the back. Sleeve buttons, brooches, beads and small charms are also made of these. Snuff-boxes, salt cellars, jewel caskets and other articles are made of the large ones. Spoon bowls, ring trays, whistles and figures of animals are some of the incongruous objects into which these shells are transmuted. Beautiful in their natural state, they rarely gain anything in this attempted "improvement." The *price* of the cowry is augmented by the addition of ornamentation; its *value* usually drops to zero in the hands of the enterprising manufacturer of "souvenirs." Could anything be more unseemly than a handsome tiger cowry, its beauty defaced by etching upon it, with strong acids in ornate letters and flourishes, the Lord's Prayer! This I found in company with grotesque imitations of pigs and pug dogs, punch-ladles and pin cushions, all made of cowries and jostling each other on a crowded booth counter at a seashore summer resort.

A sense of the eternal fitness of things steers the person of taste by all such vulgarities; but so long as there are buyers these things will be made, and we shall see them decorating (?) mantelpieces and "what-nots" in comfortable American homes. Beware the person who, seeing a beautiful sea shell, undertakes "to make something out of it." The result is almost always inartistic, and useless. If we have fallen unthinkingly into the snare, let us atone for our fault by destroying the poor, mutilated thing forthwith.

The **Money Cowry** (*C. moneta*, Linn.) varies from deep canary yellow to white; the back of variety *annula* is encircled by a faint ring of dull red or orange. The shells are heavy, with thick, angled margins, smooth or noduled bases and blunt teeth in the apertures. In length the forms vary from $\frac{3}{8}$ to $1\frac{1}{2}$ inches. They live on the reefs of coral islands, but are happiest on sandy mud flats

The Cowries. Venus Shells

A collector describes the animal as creamy white, the mantle elegantly veined with black, and fringed with numerous simple processes, ringed with white and tipped with lilac. The snout is buff, the tentacles veined with black, and the siphon yellow with fringed tip.

Habitat.—Indian Ocean, Pacific Islands, Australia.

Various shells furnish the raw material out of which *wampum* and other money of aboriginal tribes are made. The money cowry is a ready-made currency, like the tooth shell. It requires only to be strung. The use of cowries as money dates far back into antiquity. They were found in the ruins of Nimrud. Marco Polo found them in circulation in Yunnan, in the thirteenth century. The earliest mention of them is contained in a Hindoo arithmetic of the seventh century, A. D. Translated, the "example" reads as follows:

The $\frac{1}{4}$ of $\frac{1}{16}$ of $\frac{1}{8}$ of $\frac{3}{4}$ of $\frac{3}{4}$ of $\frac{1}{2}$ a drama was given to a beggar by one from whom he asked an alms; tell me how many cowry shells the miser gave.

Traffic in cowries has made fortunes for Dutch and English traders whose merchantmen get their cargoes in Zanzibar, or in the Indian or Pacific Ocean, where the shells have no value. These ships proceed to the West Coast of Africa, and follow the rivers inland to where tribes live which eagerly exchange their ivory and palm oil for the coveted money shells. Cowries figure largely in the slave trade. The value of these shells differs in the regions where they are the medium of exchange. They have been demonetised in many places by contact with traders who have introduced English money. The upper Nile country is an example.

Shells that lack the glossy finish or are blue are "dead" and almost worthless. Bright, perfect, uniform shells are highest in value.

Table of the currency valuation of cowries on the west coast of Africa. Values vary greatly in inland regions.

40 cowry shells	= 1 string
2½ strings (100 cowries)	= 1 English penny
50 strings (2,000 cowries)	= 1 head
10 heads (20,000 cowries)	= 1 bag
3 heads (6,000 cowries)	= 1 dollar

In the Soudan, where the people are great traders, the only

currency they have is cowry shells. For a dollar's worth of any thing a purchaser must pay 2,000 cowries, which weigh from five to seven pounds. It is not to be wondered at that the wheels of trade drag heavily with this burdensome currency, and progress of all kinds is impeded. In some parts of Africa 3,000 shells are worth a dollar. The price of a young wife is 60,000 to 100,000 cowries—from £4 to £8 sterling. This is \$20 to \$40. An older, more ordinary wife may be had for 20,000 cowries or 25 shillings, about \$6.

The **Ring Cowry** (*C. moneta*, var. *annula*, Ads.) has already been mentioned. Mr. Arthur Adams saw the young of this mollusk clinging in a glutinous mass to the mantles of their parents. Each had a transparent, very wide-mouthed spiral shell. When put into a watch glass of sea water the shells disintegrated, and the mollusks swam rapidly about by means of two membranous wings, finally settling down.

The **Eyed Cowry** (*C. Argus*, Linn.) has as many eyes on its back as Juno's fabled peacock. Three bands of smoky brown cross the arched back, fading out into the creamy ground colour of the base. The "eyes" are rings of warm, light brown. A few of the largest are almost solid brown to the centres. Two large dark brown patches occur on each lip. The teeth are shaded with brown. Length, $2\frac{1}{2}$ to 4 inches.

Habitat.—New Caledonia, New Hebrides, Indian Ocean.

The **Measled Cowry** (*C. exanthema*, Linn.) is well "broken out" with round white spots on a chestnut ground, which fades to drab or bluish underneath. A wavy line of bluish white runs longitudinally over the back, revealing what the mottled brown areas almost conceal, three broad bands of bluish brown under-colour. The teeth are dark brown. Fine specimens are picked off of mangrove stems on the north shore at Key West. Length, 3 or 4 inches.

Habitat.—West Indies, Florida.

Variety *cervinetta*, Kiener, is a smaller shell, more cylindrical and darker than its parent species. The teeth on the columella are dark brown. It occurs on the west coast at Panama and Mazatlan.

The **Nut-brown Cowry** (*C. spadicea*, Swn.), the only species found on western beaches of the United States, occurs in Southern California. It is flesh-coloured on the sides and white below.

The Cowries. Venus Shells

On the back is a brown central area edged with a band of darker brown that follows the outline of the shell. It is not frequently found and is a prize to any collector. The shells are particularly bright and glossy when taken alive. The largest are about two inches long.

The **Stag Cowry** (*C. cervus*, Linn.) has an inflated shell lighter in weight than the preceding species and much more roomy. Its aperture is wider in front. Its white spots are close and small and usually blurred into the chestnut ground colour. Length, 2 to 6 inches.

Habitat.—Panama.

The **Tortoise-shell Cowry** (*C. testudinaria*, Linn.), the largest species in the genus, has the colouring and the mottled markings of brown tortoise shell on its back, and a multitude of white specks, like flour, sprinkled over the polished surface. The base shades into brownish flesh colour or pale fawn; the teeth are white. Young shells are obscurely banded with brown on a uniform, paler ground. Length, 4 to 6 inches.

Habitat.—Ceylon.

The **Orange Cowry** (*C. aurantium*, Martyn) is an inflated shell of ovate form with back and teeth of uniform colour, bright orange. The sides, extremities and base are white. Length, 3 to 6 inches.

Habitat.—Fiji Islands, Solomon Islands, Loyalty Islands.

Permission to wear an orange cowry as an ornament is a mark of the highest distinction granted among Friendly Islanders. Shells punctured with a hole in the back, occasionally seen in collections, have been worn, and are for this reason considered especially valuable.

For many years collectors had to pay excessive prices for these rare shells. The especial regard in which they were held by natives of the islands prevented their dispersal to other countries. An occasional traveller got hold of one for \$25. Now perfect ones may be had for \$20, says Mr. Campbell in the *Nautilus*, 1889. Unlike some more abundant species, they are obtained from deep water outside the reefs, which fact in itself should account for their scarcity and high price.

The **Map Cowry** (*C. mappa*, Linn.) is marked lengthwise with a broad zigzag line of pale chestnut from the angles of which side branches go off alternately from left to right, singly

or in twos. This band is approximately median, and marks the meeting place of the two lobes of the mantle. The back is covered with fine waving chestnut lines running lengthwise. These have scattered spots of pale chestnut which become more numerous toward the pale violet-tinged, almost colourless base.

The usual habit among cowries is to reserve the bright pattern and colouring characteristics of the species until just before the shell is full-grown, then to lay it on, covering up the bands and waves of colour that previously alternated with the white layers. In *C. mappa* there are two final coats of the same pattern laid one upon the other. Length, 2 to 3½ inches.

Habitat.—Indian Ocean.

The **Spotted Cowry** (*C. guttata*, Gray) is a rare and beautiful species which we are doomed to know only through pictures, unless we visit the Philadelphia Academy of Natural Sciences, the British Museum or the Museum of Leyden. A very few specimens exist in private collections in Europe. The price of this shell has reached the highest mark in the genus. In 1866 one sold for £42. Two I know of in this country. One is in the Philadelphia Academy of Natural Sciences, the other in the collection of Mr. Richey of Boston.

The base is crossed by close sharp ridges which round the margin, and come up a little way on the sides, giving the shell a crimped border all around. This border forms a recurved flange. The back of the shell is orange-brown with pale spots of varying sizes. The cross ridges are bright orange red, giving the base and border a striking colour contrast. Length, 2½ inches.

Habitat.—Red Sea, New South Wales.

The **Prince Cowry** (*C. princeps*, Gray) was long known only by a solitary specimen in the British Museum. This was a superb shell, thinner than other cowries, very much swollen in the middle, and elevated, sloping steeply to the base on all sides. The yellow ground colour of the back shades into pink, as it descends to the colourless base. A patch of brownish wavy lines like closely written characters occupies the middle of the back. A squarish blotch of darker brown stands on either side of this middle patch. The sides are spotted. The extremities have three concentric brown lines. The base and teeth are white.

The first specimen was found in a private collection; it

was labelled "The Brindle Cowry of the Persian Gulf." No further history of its has ever come to light. A second was found on the southern shore of New Guinea. It is very high priced. Mr. McCoy of Chicago has the only one I know of in America.

The **White-tooth Cowry** (*C. Leucodon*, Brod.) ranks with it in rarity and value. The sole specimen known is in the British Museum.

The **Tiger Cowry** (*C. tigris*, Linn.) achieves its handsome mottled shell colouring by a devious and interesting process. First it is a uniform chestnut bay; the colour then breaks up into bands of close-set wave blotches of a richer hue; a coating of white is then superimposed, and upon that is deposited a series of rather distant zigzag flames. The rich colouring of the first state is concealed. In the next state a second layer of white is superimposed and upon this surface a number of dark spots are deposited. These are again overspread by a third white coating intermixed with numerous rich black and brown spots.—*Reeve*.

The animal of *Cypræa tigris* has more colours than the shell. A naturalist who collected specimens from three to five inches long off Cook's Island described the body with some minuteness. The upper surface of the foot is dark brown marbled with black and streaked with fawn colour. The sole is purple, shaded with brown, and veined with black. Head, siphon and tentacles, are gray. The mantle is creamy yellow, with scattered brown spots, and longitudinally veined with brown. The mantle fringe is amber, tipped with white.

These cowries hide from the sun among the coral masses in shallow water. When a specimen is discovered by the collector it is seen with its shell entirely swallowed up in the dark mottled and curiously tufted mantle, which has the peculiarity of changing its intensity of colour at the will of the mollusk. Touching it with a stick causes the mantle to withdraw quickly into the shell, exposing the polished back and sides. To clean a shell one must first let the animal parts decompose. It is impossible to remove the body by force when still fresh. Length, 3 to 5 inches. Indian and Pacific oceans.

The rat cowry, the serpent's head, the rhinoceros and stag cowries are named for some fancied resemblance to these animals. The panther, lynx, leopard and cat cowries have colouring and markings suggesting these fur-bearers.

THE COFFEE-BEAN SHELLS

Genus TRIVIA, Gray

Shells cross-ribbed, roundish, with a concavity on the inner face of the ribbed columella. Mantle covered with papillæ; foot extended far out behind the shell.

The **Coffee-bean Shell** (*T. pediculus*, Linn.) is a pinkish button-like shell, tinged with brown and marked with six large black spots on the back, three on each side of the median depression which runs lengthwise of the shell. Strong cross ridges encircle the shell, and continue into the aperture. Length, $\frac{1}{4}$ to $\frac{3}{4}$ inch.

Habitat.—Florida, West Indies.

The **Four-spotted Coffee-bean** (*T. quadri-punctata*, Gray) is a bit smaller, with finer cross ridges, purplish, with four small but distinct black dots along the median groove.

Habitat.—Florida Keys, West Indies.

The **California Coffee-bean Shell** (*T. Californica*, Gray) is about the shape and size of a large grain of coffee. The dorsal depression is shallow, the twelve ribs are white and somewhat far apart. The purplish brown of the shell is dull beside the vivid scarlet of the body. When the creature extends its long tentacles and proboscis in front and its broad foot behind, the shell is swallowed up by the mantle, and makes the bright red dull by its purple showing through.

T. Solandri, Gray, is twice the size of the previous species, with stronger sculpture, and a paler purple between the ribs. There is an additional tooth between each two ribs of the outer lip.

Habitat.—Santa Barbara, Cal.

T. sanguinea, Gray, has a bloody spot on the middle of the back. The ground colour is purplish, the ribs whitish. Length, $\frac{1}{4}$ to $\frac{1}{2}$ inch.

Habitat.—California southward.

The **European Cowry** (*T. Europæa*, Montagu) is closely ribbed, the ground colour flesh pink, the base white. The body is bright yellow, brown and pink. The mantle is broad, its surface covered with papillæ, brownish yellow or white, often dotted with scarlet and purple. Length, $\frac{1}{4}$ to $\frac{3}{4}$ inch.

The Cowries. Venus Shells

The animal is very active but also shy, quick to withdraw into the shell at the first sign of danger. "Nun" and "Stick-farthing" are names by which this plentiful mollusk is known on some parts of the English Coast. "Gowry" was the old form of "Cowry."

Charles Kingsley describes this mollusk as hanging a few inches below a rock to which it has attached itself by a glutinous thread. He also saw it float in an aquarium by means of a glutinous bubble to which it had a similar thread attachment.

The distribution of this species on stony bottoms from low water to 100 fathoms depth, and from the Mediterranean to the Norwegian coasts, indicates unusual powers of adaptation to different temperatures and depths. The largest forms occur farthest north.



COWRIES AND COFFEE BEAN SHELLS

- | | | | |
|---|---|------|--------------------------------------|
| 1 | California Coffee Bean Shell, <i>Trivia Californica</i> . | 3, 4 | Tiger Cowry, <i>Cypraea tigris</i> . |
| 2 | Florida Coffee Bean Shell, <i>Trivia pedicula</i> | 5 | Argus Cowry, <i>Cypraea Argus</i> . |



EGG SHELLS

- | | | | |
|---|--|---|--|
| 1 | <i>Ovulum volva.</i> | 3 | <i>Ovulum ovum.</i> |
| 2 | <i>Ovulum uniplicata</i> on branch of sea fan. | 4 | <i>Ovulum ovum</i> , showing internal structure. |

CHAPTER XXI: THE EGG SHELLS

FAMILY OVULIDÆ

SHELL involute, body whorl covering the spire, smooth, porcellanous, whitish or dull in colouring; aperture long, its extremities usually drawn out to form two canals; inner lip smooth, outer usually ridged, bent inward; foot large; mantle reflected over shell when in use. One genus of fifty species in warm seas.

Genus OVULA, Brug.

The egg shells are close to the cowries in structure and habits. Unlike them, the spire of the shell is concealed from the first, and the columellar lip is rarely toothed. The egg form is modified by the two terminal canals.

The **Swollen Egg Shell** (*O. gibbosa*, Linn.), somewhat over an inch long, has a thick shell, blunt at the ends, highly polished, with brown clouding on a pale ground. The lips are thick and free from teeth. A swollen band encircles the shell midway between the ends.

Habitat.—Florida.

O. acicularis, Lam., is very smooth, slender and thin; colour, purplish or yellow. It is found closely attached to stems of sea fan. Length, $\frac{3}{4}$ inch.

Habitat.—South Carolina, Florida, West Indies.

O. uniplicata, Sby., of similar habits, colour, shape and size, is distinguished by a distinct fold on the columella near the posterior end of the shell. Length, $\frac{3}{4}$ inch.

Habitat.—North Carolina to Florida, Southern California.

The Californian forms are purple or violet, with pale lips. In the southeast there are two solid colours, yellow and purple, as in the sea fans on which this mollusk lives. If a yellow fan, then it will require sharp eyes to find the yellow shells closely applied to the stems. If the fan is purple, the shells are purple.

The Egg Shells

The **Great Egg Shell** (*O. ovum*, Linn.) is as large as a goose egg, white, tapering from its swollen middle to the blunt, canalculated extremities. The animal is black, with stout tubercles covering its reflected mantle lobes. The shell lining is brown. The lip is incurved and wavy toothed.

The Pacific Islanders in holiday attire have these white egg shells hanging from elbows, wrists, ankles and belts. They use them very effectively in decorating their canoes, houses and temples.

A similar, but smaller species, *O. tortilis*, Martyn, with rose-coloured lining, comes from Zanzibar and the Friendly Islands.

O. volva, Linn., has a canal at each end as long as the oval shell, making a total length of from three to five inches. The exterior is crossed by remote striations. The colour is a brownish flesh colour.

Habitat.—China, Japan, Philippines.

The **Poached Egg** (*O. patula*), the little English species, is yellow, fading into white. It lives among colonies of zoöphites, resembling our slender thin-shelled species of the Southeast.

The valuable cargoes of sandal-wood obtained in some of the Pacific islands for the China market are, in the first instance, purchased from the New Hebrides by means of a shell—the *Ovulum angulosum*, a white, porcellaneous variety of cowry with a violet-coloured lip—which is found in the Friendly Islands, but never in the sandal-wood region. This shell is so highly esteemed as an ornament by the natives of the New Hebrides that for one shell they will give in exchange a ton of sandal-wood. The trading captains go expressly to the Tongan archipelago for the shells, where they sell at a Spanish dollar each.—*Simmonds*.



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UNIVALVE SHELLS OF TROPICAL SEAS

- | | |
|---|--|
| 9 Prince Cone Shell, <i>Conus princeps</i> , Linn. | 13 Bull's Mouth Helmet Shell, <i>Cassis rufa</i> , Linn. |
| 10 Little Moon Shell, <i>Natica canrena</i> , Linn. | 14 Granulated Cone Shell, <i>Conus granulatus</i> , Linn. |
| 11 Bubble Cone Shell, <i>Conus bullatus</i> , Linn. | 15 Fighting Conch, <i>Strombus pugilis</i> , Linn. |
| 12 Textile Cone Shell, <i>Conus textile</i> , Linn. | 16 Cross-barred Shell, <i>Cancellaria reticulata</i> , Linn. |
| | 17 Papal Mitre, <i>Mitra papalis</i> , Linn. |

CHAPTER XXII: THE HELMET SHELLS. CAMEO SHELLS

FAMILY CASSIDIDÆ

SHELL heavy, thick, sub-globular, or three-cornered; spire short; whorls sometimes varicose; aperture long, ending in front in a recurved channel; columella thick, widely spread out, with folds; outer lip thickened at margin and toothed within; operculum horny, concentric, fan-shaped; head large; tentacles with eyes at base; snout extensible; foot large; mantle large.

An energetic, predatory family, living along sandy shores of warm oceans, and preying upon various bivalve mollusks.

Genus CASSIS, Lam.

Characters of the family. Twenty-five species.

The **Red Helmet** or **Bull's Mouth** (*C. rufa*, Linn.) has a cowry-shaped brown shell, oval in outline, but with a broad spire. The surface is finely cancellated. The body whorl has three rows of low knobs. The broad, toothed lips are clouded and barred with bright orange-red, shading darker between the teeth. A wide enamel callus coats the columella. Length, 5 to 7 inches.

Habitat.—Indian Ocean, Japan.

The **Black** or **Cameo Helmet Shell** (*C. cameo*, Stimps.) was wrongly named *C. Madagascarensis*, by Lamarck, for it is not an inhabitant of Oriental seas. It is yellowish with brown markings. The distinguishing character is the painting with dark brown of the spaces between the ridges that surround the aperture. These cross streaks are short and distant on the lip; longer and close-set on the columella. Three spiral ridges revolve about the body whorl, bearing knobs. Length, 10 inches.

Habitat.—Beaufort, N. C., to West Indies.

The **Sardonyx Helmet** (*C. tuberosa*, Linn.) has a three-cornered outline, and the surface is crossed by fine lines, both

longitudinal and spiral. Three rows of distant nodules occur on the hump-backed body whorl. Brown blotches of varying size ornament a yellow ground. The pale ground of the broad columella is overlaid by dark brown streaks between the plications, and toward the posterior end of the aperture a big patch of bright chestnut occurs. A few large brown spots are disposed around the margin of the outer lip. This is one of the preferred cameo shells; the white figure stands out clearly against a black background. Length, 6 to 8 inches.

Habitat.—North Carolina to West Indies.

The **Flame Helmet** (*C. flammea*, Linn.) has a high, singly ridged, conical spire, and is decorated with browns in flame-like crescentic patterns, even on the face of the expanded columellar lip. Big blackish spots follow the lip margins around. Strong knobs range along the shoulder of the body whorl, with two fainter and shorter parallel rows lower down. Length, 4 to 6 inches.

Habitat.—West Indies.

The **Horned Helmet** (*C. cornuta*, Linn.) is studded with three spiral rows of tubercles, between which the surface is finely honeycombed and has series of parallel rows of fine dots, the area clouded with brown. Blotches of dark brown occur on both lips and on the rows of knobs. The ground colour is creamy white. One strong varix runs down behind the columellar lip.

This is not only the giant of its family, reaching a foot in length, but its distribution is over a belt that encircles the globe. It inhabits the Indian Ocean, the Philippines, Japan and the West Indies. In cameos it gives a white raised figure on an orange or pink ground.

CAMEO-CUTTING

The black helmet is one of the best shells for cameo-cutting. It has an "onyx ground," a dark coat under the pale outer layer, so that the figure cut will stand out well. The inner lip of a large shell should yield several brooches. Usually the background is claret-coloured, instead of black.

The bull's mouth is red under a white outer coating. This is known as a "sardonyx ground." *C. cornuta* cuts a white figure on an orange ground. The queen conch (*Strombus gigas*) is pink over a white ground.



HELMET SHELLS

1 *Cassis tuberosa*.

2 *Cassis cameo*.

3 *Cassis testiculus*.

4 *Oniscia tuberculosa*.



TUN SHELLS AND HELMET SHELLS

1 *Dolium galea*.

2 *Dolium perdx*.

3 *Cassis inflata*.

4 *Cassis tuberosa*.

The two semi-precious stones named in the descriptions of cameo shells call attention to the fact that cameo-cutting, one of the fine arts of antiquity, used stone only as material, for centuries. Then lava came to be used for cheap work. Shells were first used in 1820 in Italy. The best shell cameos are made in Genoa and Rome. Many cutters are at work in Paris.

C. cornuta has the fault of "doubling" occasionally: that is, its two layers separate, and the work counts for naught. The pink queen conch has the fault of fading. At best, it furnishes but one good brooch.

The red underlying the white in *C. rufa* becomes thinner and paler as it extends backward, so a single brooch and a few cuff buttons or shirt studs are all a big shell can be expected to yield. Still, the enamel is so thick and the colours so good, this species will always remain in great request for cameos. There are often twenty laminæ or layers of enamel on the lip. Besides cameos, beads are cut from the linings of helmet shells.

CHAPTER XXIII: THE TUN SHELLS. WINE JARS. FIG SHELLS

FAMILY DOLIIDÆ

SHELL thin, ovate or sub-globular, with stout spire and swollen body whorl; generally with strong spiral ribs; aperture generally wide, with canal at base; operculum only in immature stages; body large, with spreading mantle; head large; eyes on sides of tentacles; proboscis remarkably large and long, flexible; foot lobed, spread out into a truncated front margin in which there is a horizontal groove. A small family of large mollusks living in seas of the tropics. Sometimes called "wine jars," because they are so capacious.

Genus DOLIUM, Lam.

Shell almost globular, with wide mouth; lip ruffled; columella channeled; basal canal straight. Used for lamps, vases, etc. Fifteen species.

The **Helmet Tun Shell** (*D. galea*, Linn.), one of two species found on our coast, is a good type of the family. The shell is eight to nine inches long and fully as broad. Unlike the conchs and helmets, the tun shells are thin and light in weight, though large. The spire is small and sunken, with a deep suture in the large body whorl which constitutes the greater part of the shell. The surface has a series of parallel, deep cut, revolving grooves crossed by many faint lines of growth. The even fawn colour of the exterior is brightened by dashes of darker brown on lip, columella and spire. The umbilicus is narrow and deep.

Habitat.—North Carolina to Brazil.

The **Partridge Tun** (*D. perdix*, Linn.) is marked with crescents of white on a brown ground colour, strikingly resembling the plumage of a partridge. The spire of this species is much elevated. The unusual range is noteworthy. Length, 5 to 9 inches.

Habitat.— Indian Ocean, Polynesia, West Africa, West Indies, Florida Keys, Brazil.

The **Apple Tun** (*D. pomum*, Linn.) is a solid little shell, yellowish brown, clouded and mottled with white in about equal proportions. The spire is depressed, with a deep suture; the whorls bear broad, low, rounded ridges. The columella is ridged and umbilicated, with a slight excavation in the middle. An external groove sets off the flaring lip, which is thickened and crossed by sharp ridges just back of the incurving edge. These shells are rather heavy for their size. Length, 3 inches.

Habitat.— Red Sea, Indian Ocean, Philippine Islands.

Sub-Genus **MALEA**

The **Grinning Tun** (*D. ringens*, Sw.) is the heaviest species in the genus. The *grin* is produced by the turning backward of the outer edge of the lip. The columella has a distinct excavation in the middle with prominent ridges above and below it. The exterior of the shell has deep wide grooves and rounded ridges which give the flaring lip a scalloped edge. Length, 4 to 9 inches.

Habitat.— Peru and Panama.

Genus **PYRULA**, Lam.

Shell very thin, pear-shaped, finely ribbed, cancellated, ending in an open canal at base; spire depressed, short; lip thin, smooth; operculum and umbilicus wanting. Foot large, with wide spread; siphon, head and tentacles much elongated and narrow; mantle lobes reflected over sides of shell in use. A few species only.

The **Paper Fig Shell** (*P. papyratia*, Say) is found from Beaufort, N. C., down the coast to the West Indies. I have picked up many fine specimens on the Gulf coast of Florida; how the delicate, almost transparent, things escape shattering in the surf is more than I can explain. I never saw the living mollusk. The general colour of the shell is brownish white with faint brown lines drawn down from the spire. Inside, the brown is darker. There are no spots on the finely cancellated surface. Length, 3 to 4 inches.

Arthur Adams describes an East Indian species as a very

The Tun Shells. Wine Jars. Fig Shells

shy and sensitive mollusk, hurrying along on its broad foot and carrying its light shell with ease and grace. In captivity it climbed the sides of its glass prison with equal ease and celerity. Wonderful blending of dainty colours he saw in the extended foot, mantle and head: pink and violet elegantly marbled and dotted with red and yellow. In front the long neck bore the head aloft, and the large black eyes peered about in a remarkable manner.

The **Turnip Shells**, genus *Rapa*, are illustrated by *R. papyrifera*, which exaggerates the characters of the graceful paper fig shell.

CHAPTER XXIV: THE MOON SHELLS AND VELVET SHELLS

FAMILY NATICIDÆ

SHELL globular or ear-shaped, with wide aperture; foot very large, prolonged in front and behind; radula large; mantle often engulfing the shell. Predatory mollusks which burrow in the sand for bivalves.

Genus NATICA, Lam. (LUNATIA, Gray)

Shell oval, globular, solid, porcellanous, smooth, with transparent epidermis, umbilicated; operculum large, semi-lunar; foot broad in front, furnished with an upper fold that is reflected back over the head and front margin of the shell. Eggs laid in collar-shaped band covered with sand. Active, carnivorous mollusks, living in temperate and warm seas.

The **Moon Shell** (*N. heros*, Say), round and smooth as an apple, is a familiar object on our east coast. The spire is flattened and very small, the coils few; the last whorl, very much larger than the others, ends in an ear-shaped aperture. The large umbilicus extends to the apex, which is often worn off, letting water pass through. The colour of these shells is ashen, streaked or clouded with brown inside and out. Dead shells are soon wave-worn and disintegrated; the protective epidermis goes with their lost youth. The operculum is horny and spiral, the nucleus near one edge.

No adornment is to be seen upon the strong house that shelters this businesslike mollusk butcher. He rolls up his sleeves, so to speak, and goes after his prey in dead earnest. Put one in a tank of sea water, with sand in the bottom, and before long he recovers his equanimity, and unlocks his door. The amount of foot he unfolds is a matter of amazement when the size of the shell is taken into account. A flattened pad of flesh three times as long as the shell's diameter, and half as wide as long—this is

The Moon Shells and Velvet Shells

the burrowing, gliding organ of locomotion. In shape it is somewhat like the bottom of an old-fashioned flatiron; the broad, truncated end is forward. A fleshy band on top of the foot folds back over the head, protecting it as the burrowing foot drags the body rapidly after it through the wet sand. The eyes are wanting or buried under a thick epidermis.

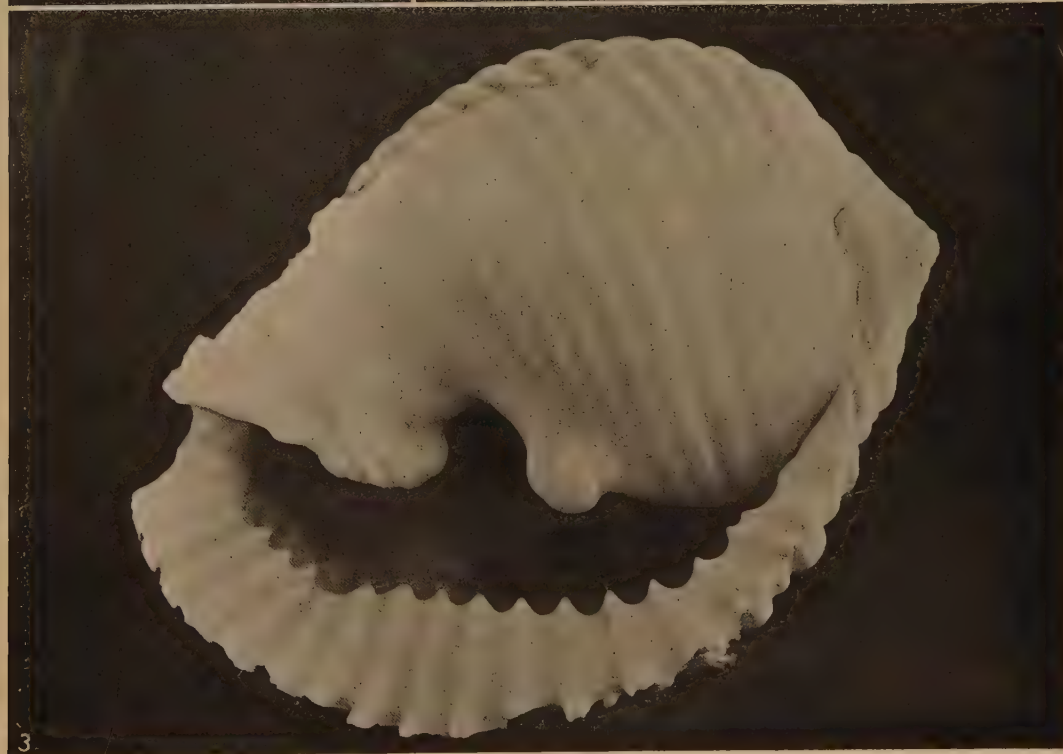
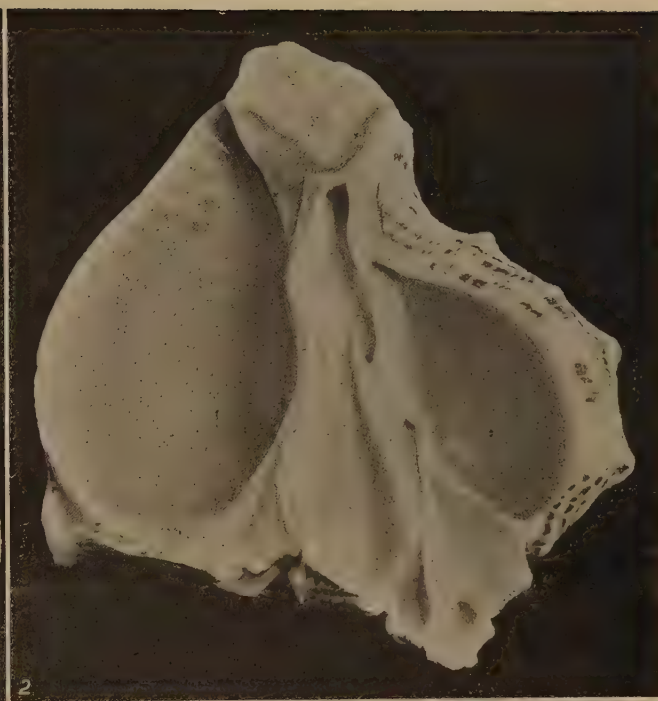
This blind, mole-like mollusk finds plenty to eat in the zone just under the surface of the sand. Clams and other shell fish are there. Down comes the hood from over the head when a victim is met. The long proboscis is set, and the radula it contains soon has a neat round hole drilled in the shell, through which the soft parts are extracted by the sucking mouth of the bloodthirsty *Natica*.

The largest holes drilled in various bivalve shells are usually charged to the *Naticas*, although the evidence is partly circumstantial. The activity of the mollusk argues a keen appetite, and its predatory reputation is quite lived up to if a single specimen is put into an aquarium with clams and a variety of other mollusks of less strenuous habits. Well may *Natica* be bold, for at the least warning of danger it draws in the foot, and the horny operculum locks the door tight.

The eggs are laid in a sticky mass of clear jelly which is moulded over the shell; this explains its peculiar collar shape. There is but one layer of egg cases, arranged in regular quincunx order. A layer of fine sand covers each side of the collar, making it about the thickness of an orange peel. While this remains in the water the mucus is rubber-like, and the eggs are safely concealed under the protective film of gray sand. Cast ashore the sand collar becomes dry and brittle. Who has not seen these collars, six inches in diameter and open at one side, lying on the beach? It is useless to try to carry one home without having it shattered. Near hatching time the sand falls off, and the eggs become visible.

N. heros ranges along shore in sand or mud, devouring, besides living bivalves, dead fish and other victims of accident. On New Jersey beaches the surf clam (*Macra solidissima*) seems to be the prey it prefers. Its method is to clasp the victim in its voluminous foot while the drill attacks the shell near the hinge. Diameter, 3 to 4½ inches.

Habitat.— Maine to New Jersey.

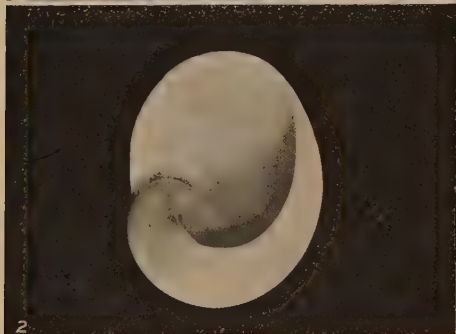
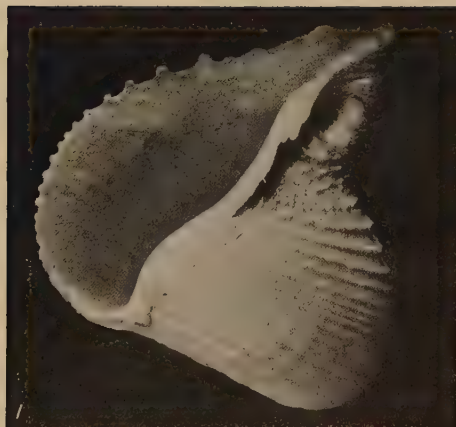


LARGE MARINE SNAILS

1 Paper Fig Shell, *Pyrula papyraria*.

2 Turnip Shell, *Rapa rapiformis*.

3 Grinning Tun Shell, *Malea ringens*.



MOON SHELLS AND OTHERS

- 1 Turnip Shell, *Rapa papyracea*.
2 Ear Shell, *Sigaretus perspectivus*.

- 3 Velvet Shell, *Velutina levigata*.
4 Moon Shell, *Natica canrena*.

- 5 Moon Shell, *Natica heros*.
6 Same, showing internal structure.

The **Western Moon Shell** (*N. Lewisii*, Gld.) is the largest species known. The shell is lighter and thinner than in *N. heros*. Faint spiral striations are seen on the whorls; the body whorl has an angular shoulder. The outside is yellowish white, the lining polished and stained brown. A callus lobe narrows the mouth of the deep umbilicus. This "snail of prey" has the same predatory habits as its counterpart of the east coast. Diameter, 3 to 5 inches.

Habitat.—California to Alaska, Japan.

N. duplicata, Say, has a flatter spire and a smoother shell than *N. heros*, with bluish tinge on the pale brownish upper surface. The distinguishing feature is a thick brown lobe that extends over the wide umbilicus, but does not quite close it. The spiral umbilicus is also distinctive. The sand collar is ruffled on its outer border. This species reaches but three inches in diameter. It has the same habit as *N. heros*, and a much wider range.

Habitat.—New England to Florida, Gulf of Mexico.

N. clausa, Brod. and Sby., is a whitish moon shell, $\frac{1}{2}$ inch to 2 inches across, which has the small umbilicus entirely filled by a callus. The operculum is calcareous, bluish white. It is found in cold seas and at considerable depths.

Habitat.—Greenland to Massachusetts.

N. Recluziana, Desh., has a more conical shell than the eastern species, in fact is rather a turban shell in form, and very thick and heavy, with brown banded whorls shading to pale ash colour. It is about 2 to 3 inches long. The umbilicus is closed by a very thick enamel callus. The "sand collar," shaped like a horse's hoof, often has rows of the eggs of *Nassa* along the top.

Habitat.—Southern California.

N. canrena, Linn., is a Floridian and West Indian moon shell found also along the Atlantic to Cape Hatteras. The shell has spiral chestnut bars streaked diagonally with purple on a whitish ground. The base is not coloured. The wide aperture is purple-lined. The umbilicus is partially plugged with a callus. The operculum is calcareous. This is one of the small *Naticas*, being 1 to $1\frac{1}{2}$ inches in diameter.

Some tropical moon shells are highly polished and brilliantly coloured. The Philippines furnish several of these, the "zebra,"

and "painted" moon shells, suggesting in their common names their colouring and marking.

Genus SIGARETUS, Lam.

Shell ear-shaped, white, solid, flattened; spire lateral; aperture oblique, flaring; operculum very small; umbilicus wanting; foot very large, especially the burrowing part in front. It lives in muddy sand flats of warm seas.

S. perspectivus, Say, differs from the *Naticas* in form and in its manners. The flattened white shell is shaped like that of a *Haliotis*. It is called "ear shell," a good descriptive name. The immense foot suggests its relation to the moon shells. But the aggressive methods of the previous genus are a striking contrast to the halting timidity of this one. It is a slow and cautious citizen. It may well be apprehensive, for the body is exposed to dangers unknown to *Natica*. When the foot is contracted to the compass of the shell, the operculum is little or no protection, for it is a thin button, by no means large enough to cover the exposed surface of the body.

This mollusk is a dainty morsel to the various "littoral pigs" that root for their daily rations in the wet sand. In its turn, it falls upon the oyster which is smothered by being enveloped in the folds of the muscular body.

Rare on northern beaches, it becomes more abundant as we go down the Atlantic coast. A dotted form, *S. maculatus*, Say, is met on the beaches of Florida. Length, $1\frac{1}{2}$ inches.

Habitat.—New Jersey to Florida.

The **Frail Ear Shell** (*S. debilis*, Gld.) is a very delicate, shallow saucer of white china, with a small spire at one end. The surface is beautifully cancellated. The creature lives just under the sand. Its food is small bivalves. Length, 1 inch.

Habitat.—Southern California.

Genus LAMELLARIA, Montagu

Shell ear-shaped, internal, thin, pellucid, spire small, lateral; aperture large; operculum wanting.

L. Stearnsii, Dall, is a thin, white, ear-shaped shell which in life is quite swallowed up by the mantle. Length, about $\frac{1}{3}$ inch.

Habitat.—Monterey, Cal.

L. rhombica, Dall, white, and found in the same locality, is larger, has a squarish aperture; the reflexed mantle does not cover the shell.

L. pellucida, Verrill, with a delicate transparent ovate shell, containing a yellowish brown animal, has been dredged from deep water off Martha's Vineyard. Length, about $\frac{1}{2}$ inch.

The Lamellariæ come from deep water in February to spawn in the shallows. Their food consists of polyzoans. When about to lay her eggs a female eats a hole in a jelly-like compound ascidian, and in this makes a nest like a deep pot, lays the eggs in it, and covers them with a tight lid. As the young develop the nest rises above the level of the surface in which it was buried. The lid flies open at the proper time, and the fry emerge.

THE VELVET SHELLS

Genus VELUTINA, Flim.

Shell thin, ear-shaped, mostly external, calcareous, fragile, covered with a velvety or powdery epidermis; aperture large, round, without operculum; foot large, oblong. Marine, living among stones near low tide, or out at sea.

The **Velvet Shell** (*V. lævigata*, Pennant), found northward from Cape Cod, is a transparent pinkish shell with a horny brown epidermis, velvety along the minute revolving striæ. It is about $\frac{1}{2}$ inch in length. The same species occurs from California northward. At Vancouver Island it is about the size of a pea. The velvet and the epidermis are easily removed, after which the shell falls to pieces.

This delicate creature is able to exude a frothy white slime in considerable quantity. It is doubtless protective, serving to conceal the mollusk from enemies.

CHAPTER XXV: THE SLIPPER SHELLS. CUP-AND-SaucER LIMPETS

FAMILY CALYPTRÆIDÆ

SHELL limpet-shaped with more or less spiral apex, porcelainous, interior polished, usually with a septum or internal plate of variable shape; operculum wanting; foot flattened; body not twisted; gill deeply and finely feathered; head with long snout; eyes near external bases of tentacles.

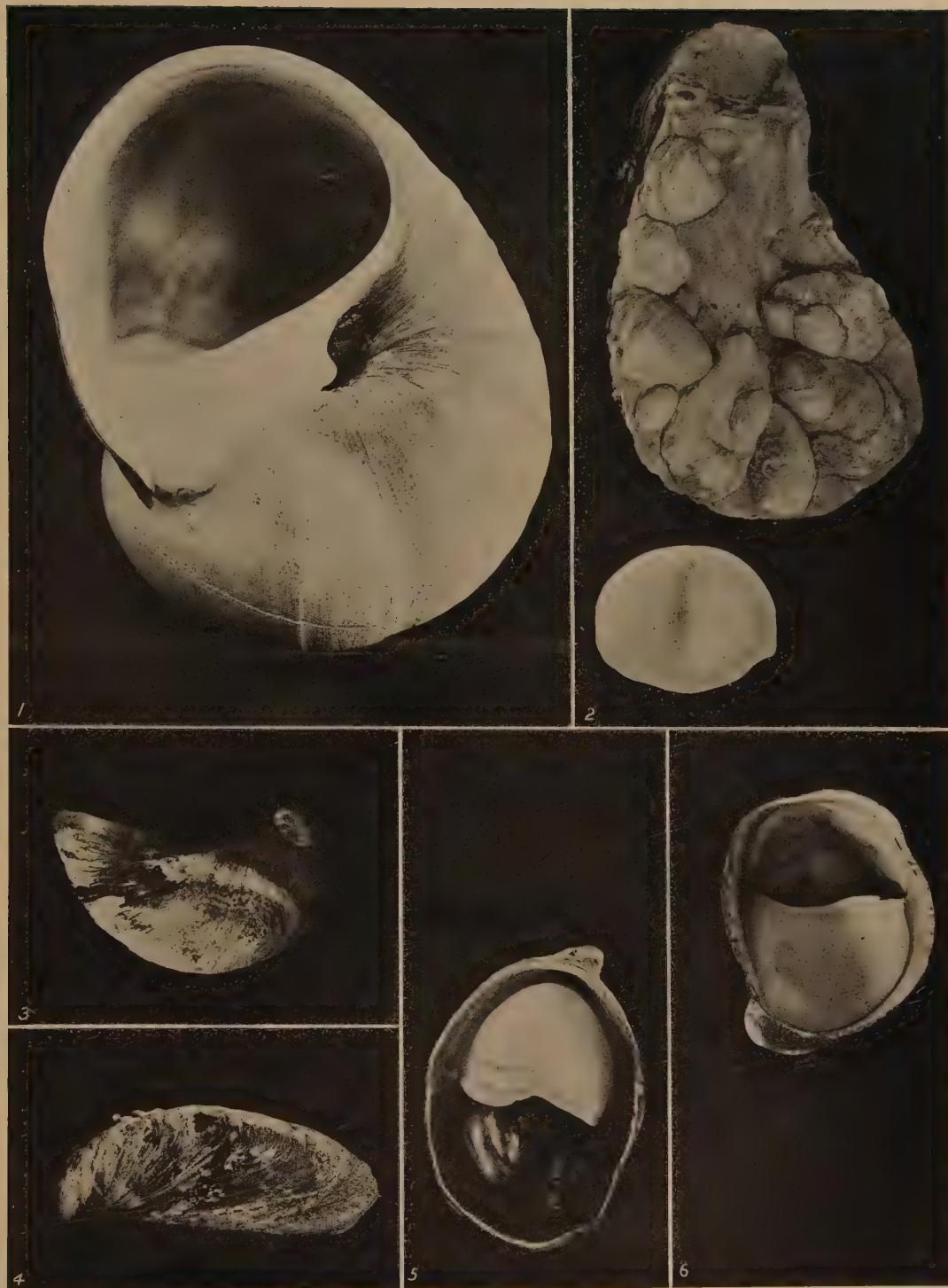
The limpet-like mollusks of this family are found adhering to stones and shells. It is likely that most of them stay in one spot all their lives. They adapt the shape of their shell to the irregularities of the chosen location, taking on the same sculpture often, and the same colours. They feed on seaweeds and animalculæ that come their way, occasionally devouring a fellow mollusk. Some genera lay their eggs under the foot as in a brood pouch. The body is supported by muscles attached to the shelly process inside the shield.

THE SLIPPER SHELLS. BOAT SHELLS. SLIPPER LIMPETS

Genus CREPIDULA, Lam.

Shells oval, with a horizontal plate closing about one-half of the aperture. Apex lateral, spiral; head flat; foot short; very common shells on all American beaches.

The **Arched Slipper Shell** (*C. fornicata*, Linn.) is loved by children, it is useful in so many ways when seaside play-houses are to be furnished. The boat shape appeals to the imagination, with its broad bottom, its rounded stern and comfortable seat. Balanced on the table and on cupboard shelves these shells are the little housekeeper's joy in setting forth dolls' tea



SLIPPER SHELLS AND GIANT MOON SHELL

- 1 *Natica Lewisii*. 2 *Crepidula plana*, in old oyster shell. 3, 4 *Crepidula onyx*. 5, 6 *Crepidula fornicata*.



LIMPETS AND CARRIER SHELLS

- 1 Hungarian Cap, *Capulus Hungaricus*.
- 2, 3, 4 Carrier Shell, *Xenophora conchylifera*, with dead shell fragments cemented to the conical spire.
- 5 Cup-and-saucer Limpet, *Crucibulum spinosum*.
- 6 Cup-and-saucer Limpet, *Calyptraea cinerica*.

parties. There is never any scarcity of dishes; the tide is always bringing in new ones.

Grown-up people, too, find a use for the empty shells. Fishermen at Greenport, Long Island, dredge up the accumulation of dead shells and sell them to oyster growers for "stool." This means that they are scattered over the rocky floor of new beds for the embryo oysters to settle upon. "Quarter-decks" is the trade name they go by. They are taken with the "jingle shells," which frequent the same banks, and are also excellent as oyster stool. In 1887 Greenport alone sold 130,000 bushels of the two shells to the oyster growers for \$5,200, an average price of four cents per bushel.

English oyster beds are in some places replenished with "seed" from American growers. With these young oysters *C. fornicata* has been introduced. Conditions are favourable to growth, and the "crow oyster," as it is called, has become a nuisance. The edible oyster, when overloaded with slippers, often three to six deep, is stunted and unsightly. The parasites rob the oysters of their food, and choke them besides. There seems to be no way of getting the better of the invader.

This species is the largest of its genus; the shells are from one to two inches long. The spiral apex is drawn down to one side of the posterior end of the shell. From it indistinct lines of pinkish brown, often broken into dots or broadened into streaks, paint the almost smooth surface. The polished interior is mottled with brown and violet in large patches. The partition is white and thin.

The height of the shell arch is largely dependent upon the life of the mollusk. Some individuals are free, and have very concave shells, others affix themselves to stones, or to the shells of oysters and various other mollusks. These are modified in form by the surface to which they adhere. On a scallop shell the *Crepidula* will be ribbed. Sometimes slippers are found piled one upon another in tiers of six or more. This is especially common in northern waters. They feed upon seaweeds for the most part, but have been known to eat other mollusks.

It is known that some of these mollusks move, and permanently change their positions. A certain specimen may spend a part of its life on a ribbed shell like an *Arca* or a *Pecten*, then move to a smooth shell or stone. The growth of the shell will

The Slipper Shells. Cup-and-saucer Limpets

tell the story plainly. The horseshoe crab (*Limulus*) often carries a load of upward of one hundred slippers. Length, 1 to 2 inches.

Habitat.—Maine to Brazil.

The **Flat Slipper Shell** (*C. plana*, Say, *C. unguiformis*, Lam.) is found flattened against the walls of apertures of dead shells. Growth proceeds, and the broadening shell of the slipper becomes concave on the back, parallel to the concavity of the body whorl within which it is attached. Examine the shells of *Natica* for slippers of this peculiar form.

The shell is usually white, the apex claw-like, as Lamarck's scientific name defines it. The pointed end is fitted with a triangular shelf. The other end is broad like a spade. According to Professor Conklin, the female is fifteen times as large as the male. This species is small and frail. Length, 1 inch.

Habitat.—Maine to Florida.

C. aculeata, Gmel., is common on Florida and California beaches. Smaller than the arched slipper, it resembles it in being marked with brown, and having a white "seat" in the end. The shell has radiating ribs which bear faint knobs.

This species has a remarkable world-wide distribution on warm beaches.

C. glauca is a little hump-backed species that keeps company with the small hermit crabs which live in the dead shells of the dog whelk. It is an Atlantic coast form.

The Pacific coast has several slipper shells. *C. aculeata* and *C. plana* are there. *C. adunca*, Sby., with high apex strongly recurved, is about an inch long. It is brown with a white shelf inside. This is the most common western species.

The **Wrinkled Slipper Shell** (*C. dorsata*, Brod.) is nearly round in outline, and often bent so that the shelf is two-lobed resembling the twisted cup in some species of *Calyptræa*. The thin, flat shell is brown and white, and about $\frac{3}{4}$ inch long. It is common on California beaches.

The **White Slipper** (*C. Lessonii*, Brod.) is handsomest in the form that wears ruffles on its shell, along the lines of growth. It is distinguished by its whiteness, its flatness and by the delicacy of its shelf. There is much variability in this Californian species.

C. dilatata, Lam., is $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, a broad oval shell, heavy, with shaggy surface and undulating margin, brown

above and inside. Its range covers the whole Pacific coast of America.

THE CUP-AND-SAUCER LIMPETS

Genus CRUCIBULUM, Schum.

Shell shield-shaped with funnel-shaped cup inside.

The **Cup-and-saucer Limpet** (*C. scutellatum*, Gray) has a heavy, shield-shaped shell with strong radiating ribs crossed by concentric ridges. The hooked beak is near the centre. The general colour is brown. Inside the shell is of a darker colour and polished. The variation in form, height and markings has led to the erecting of a great many species which have been reduced more recently to the rank of varieties. Young shells differ markedly from adults. Length, $2\frac{1}{2}$ inches.

Habitat.—West coast of South America.

Var. *auriculatum* is a flat form, pale brown, usually mottled with very rough radiate ridges. It is the West Indian form.

Var. *tubiferum* extends north from Chili to California. Small, close ridges radiate from the apex, certain of them bearing sharp, hollow prickles.

The **Cup-and-saucer Limpet** (*C. striatum*, Say) of our east coast is a small, pale cone with circular base and radiating ridges that form a scalloped border. The beak is hooked and almost overhangs the posterior edge of the shell. The flaring cup is attached by its side. Length, less than 1 inch.

Habitat.—Whole Atlantic coast.

Genus CALYPTRÆA, Lam.

Shell conical, with central spiral apex; aperture basal, circular; diaphragm spiral, margin twisted, free margin convex.

The **European Cup-and-saucer Limpet** (*C. Sinensis*, Linn.) is well known. Its cone is regular, with a spiral apex and circular base. The cup takes a spiral turn or two, forming a deep umbilicus. The shell is thin and smooth and round, pale yellow, shining inside. Quite often the pebble to which the young mollusk attaches itself is so small that the aperture of the shell reaches the outer limits of its surface before the adult size is

The Slipper Shells. Cup-and-saucer Limpets

reached. Unable to grow further in this direction, the shell enlarges vertically, lifting the apex but keeping the base the same size. This adaptability to environment produces great variation in form within the species.

The female lays her yellow eggs in flat capsules which are all attached to a common stalk as are the petals of a rose. Each capsule is transparent and contains about a dozen eggs. The shield-shaped shell protects the mother mollusk and her eggs. The young hatch and are kept between the foot and the stone to which the shell is attached until they acquire the neck frills of hairs by which they are equipped for a free-swimming life.

The **Chinese Hat** (*C. mamillaris*, Brod.) is a low, white cone with a central peak. It would require a doll mandarin to fit it. Inside is the characteristic twisted deck of the genus. The circular rim is $\frac{1}{2}$ inch in diameter.

Habitat.—California northward.

C. Candearia, d'Orb., occurs from Cape Hatteras to the West Indies.

THE HUNGARIAN CAPS

Genus CAPULUS, Montf.

Shell conical, without internal plate or cup; apex spiral, posterior; muscle scar horseshoe-shaped.

A genus of few species, widely distributed.

The **Hungarian Cap** (*C. Hungaricus*, Linn.) has no tassel to pull its peak over to one side and downward, but it is a perfect cap without it. The shell has fine, close, radiating lines crossed by less frequent lines of growth. A horny epidermis, often hairy, covers the outer surface, which is as white when cleaned as the polished lining. The animal is held in the shell by a strong muscular attachment. In British waters it is found attached to shells and large rocks, especially near beds of oysters and scallops, at depths varying from seven to eighty-five fathoms. The mollusks are sedentary, shaping the shell margins to fit the station, forming shallow excavations, sometimes depositing a shelly floor. They feed on minute animal organisms and seaweed. The eggs are laid in membranous cases which are attached in a single tuft to the foot under the neck.

This strange limpet-like creature is found near Iceland and off Martha's Vineyard, at 69 to 458 fathoms depth. In the South it appears off the Florida Keys and the West Indies. The average specimen is $1\frac{1}{2}$ to 2 inches across, at base, and 1 to $1\frac{1}{2}$ inches high.

Twenty fossil species are known, the earliest from Silurian rocks.

THE HORSE-HOOF SHELLS

Genus **AMALTHEA**, Schum. (**HIPPONYX**, Deifr.)

Shell thick, obliquely conical; apex hooked backward, not spiral; surface roughened; muscle scar horseshoe shaped; body oval; foot thin; head round, on slender neck; tentacles bearing eyes. Instead of an operculum, a shelly base is formed.

The **Horse-hoof Shell** (*A. antiquata*, Linn.) is found in Florida and California and in many other sub-tropical regions. It is a concave, hoof-shaped white shell with a hairy epidermis covering the scaly growth lines. The shape is variable, for the animal lives attached to rocks. It secretes a calcareous plate between the body and the object to which it adheres. Sowerby thought this was a second valve of the shell, and so described five species as a genus of bivalve mollusks.

CHAPTER XXVI: THE CARRIER SHELLS

FAMILY XENOPHORIDÆ

SHELL top-shaped, flattened, with stones or shell fragments attached as it grows; foot small, divided unequally by a groove, anterior part the larger; operculum horny.

A single genus with few species, widely distributed in tropical seas.

Genus XENOPHORA, Fisch.

These remarkable mollusks, whose family name means "carriers of strangers," deceive and thus circumvent their enemies by glueing to the growing shells pebbles, fragments of rock or dead shells, or whole ones, if small enough to be carried. So an adult shell may bristle with "lady fingers" (*Turritella*) or ladder shells (*Scalaria*), making it look at first glance like a sea urchin, or one of the spiny-toothed shells of the Murex group. If instead of the spiral shells, saucer-shaped ones are used, bivalves, like heart shells and scallops, for instance, the mollusk is careful to set them with their convex sides downward so as not to catch and impede travel which, at best, is laborious business.

A decided taste is exhibited by individuals, possibly modified by the supply of building materials. Some shells bear only rock fragments. Others are adorned with shells. Scientists have named the first group "mineralogists," the second, "conchologists." The mollusk carefully keeps the flat base of his shell free from these impedimenta, so that he may have free use of his faculties, and get a good living. From above he looks like a piece of conglomerate, a part of the sea bottom debris. Below, a mollusk, with molluscan appetite, looks out of the ample doorway of his shell. We may almost credit him with shrewdness and a sense of humour.

The foot is small and cleft. The larger half extends forward and fastens its hold upon some stable object. A mighty contraction of the foot muscle causes the clumsy creature to jump forward

dragging the trifling hind foot after. Thus the gait is anything but a smooth glide. It is a series of jumps, and a most laughable performance to behold.

The **Shell Carrier** (*X. conchylisophora*, Born.) is a top-shaped, pale brown shell marked by fine striæ overlying irregular wrinkles on the whorls. In the shell surface are inserted various dead shells, for the evident purpose of deceiving the mollusk's enemies. The shell is normally about two inches across. With its trimmings of heart shells and the like it often doubles this measure.

Habitat.— West Indies.

The **Pebble Carrier** (*X. calculifera*, Rowe) adorns the shell with bits of stone. This is a typical "mineralogist." Gracefully curved striations are concealed by the irregular decorations the mollusk superadds to Nature's efforts. Sometimes there is but a small circle of pebbles and shells of dainty and uniform size set around the shell more than half way to the peak. This exposes the main part of the shell, and seems to indicate that the mollusk chooses to make his roof beautiful at the risk of exposure. Diameter, 2 to 3 inches.

Habitat.— China.

CHAPTER XXVII: THE SUN-DIAL SHELLS

FAMILY SOLARIIDÆ

SHELL spiral, depressed, conical, top-shaped or flat; aperture angular; lip and columella simple; umbilicus wide, deep, usually with scalloped margin; lining not pearly; operculum spiral. Animal with large oval foot, notched in front; the eyes on the bases of the stout tentacles; radula with spiny teeth; jaws present.

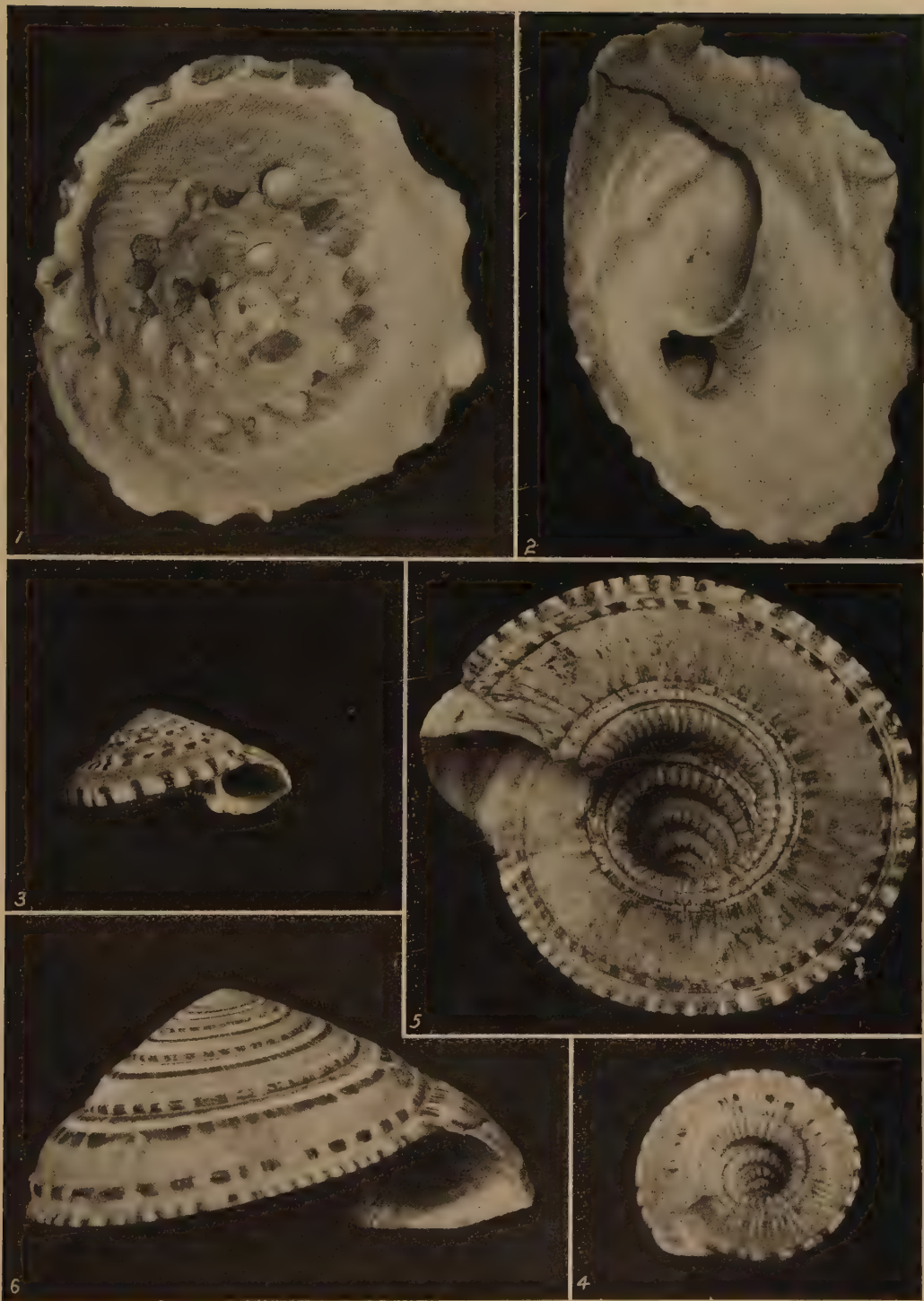
Genus SOLARIUM, Lam.

Shell a regular, depressed cone, with an angular edge; sculpture elaborate, close, strong, crossing the spiral ridges forming patterns in colours. World-wide genus in warm seas.

The **Granulated Sun-dial Shell** (*S. granulatum*, Lam.) found from North Carolina to the West Indies, and from Panama to Lower California, is finely checked by the crossing of spiral and radiating ridges, so as to have raised granules all over its upper surface. The flat base has them enlarged to nodules as it closes in to the narrow umbilicus. The surface is china-like, the whorls purplish, the upper edges white, and decorated with large brown dots in a single row. The largest specimens are about two inches across.

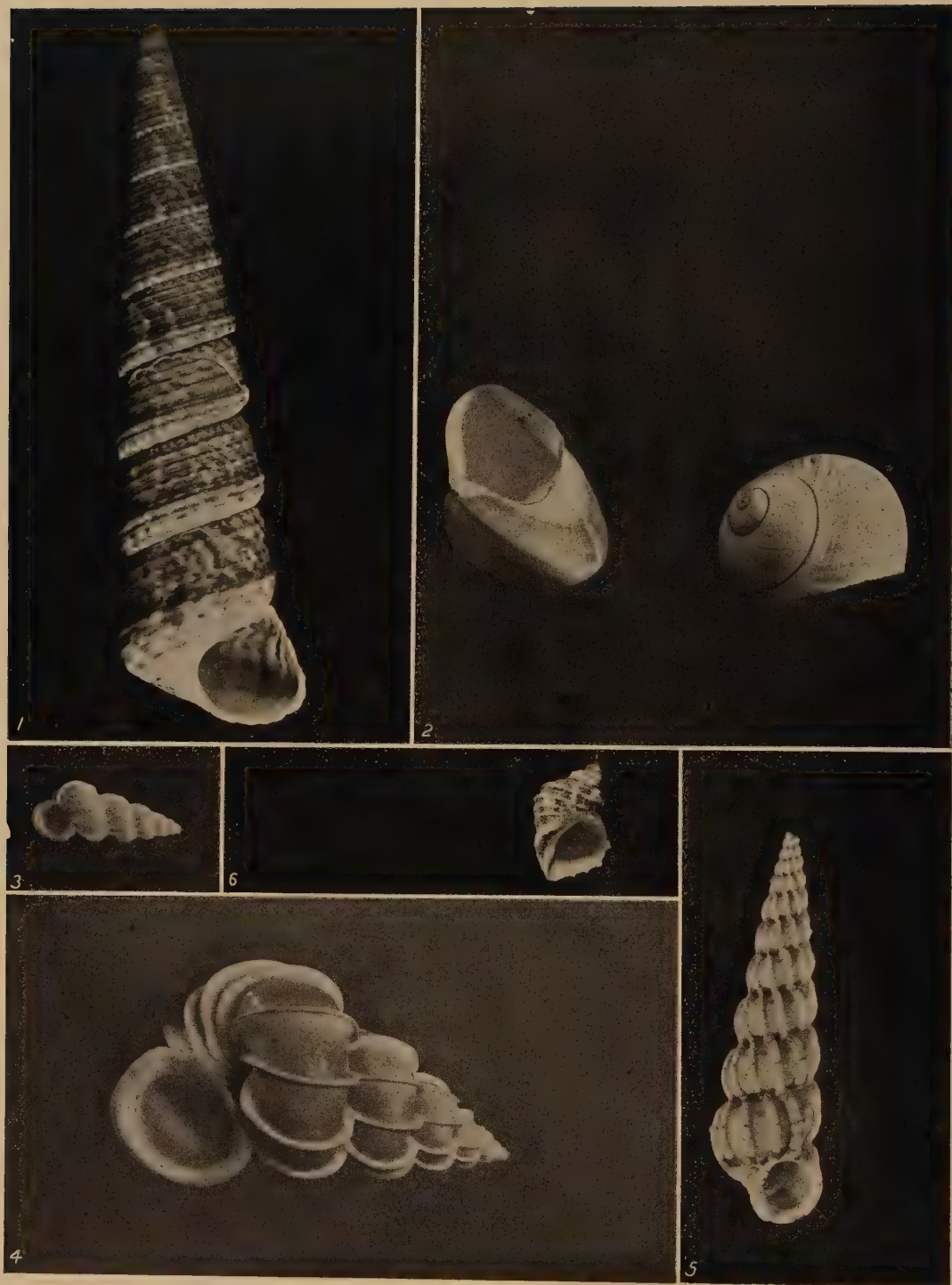
S. verrucosum, Phil., is one to two inches across, with creamy yellow ground marked with numerous short streaks of brown. The umbilicus is narrow and has prominent teeth. This species may be a form of *S. granulatum*. West Indies.

The **Oriental Sun-dial Shell** (*S. perspectivum*, Linn.) is a depressed cone with angled margin and flat base. Its whorls have a spiral depression below the sutures; this also is seen on the basal coils, and in the broad umbilicus. Narrow ridges on each side of the depression are marked with brown spots. The ground colour is yellowish brown or ashy purple. Cloudy oblique bands cross the median surface of the whorls. Diameter, 2 to 5 inches. Indian Ocean, Pacific Ocean, China to Australia.



CARRIER SHELL AND SUN-DIAL SHELLS

- 1, 2 Carrier Shell, *Xenophora calculifera*, carrying both shells and pebbles.
 3, 4 Granulated Sun-dial Shell, *Solarium granulatum*.
 5, 6 Perspective Sun-dial Shell, *Solarium perspectivum*.



WENTLETRAPS, VIOLET SNAILS AND OTHERS

- 1 Mottled Screw Shell, *Turritella variegata*.
- 2 Violet Snail, *Ianthina fragilis*.
- 3 Say's Wentletrap, *Scala Sayana*.

- 4 Precious Wentletrap, *Scala pretiosa*.
- 5 Ladder Shell, *Scala communis*.
- 6 Hairy-keeled Shell, *Trichotropis borealis*.

CHAPTER XXVIII: THE STAIRCASE SHELLS. LADDER SHELLS. WENTLETRAPS

FAMILY SCALIIDÆ

SHELL white, polished, turreted; whorls sometimes uncoiled, with longitudinal ribs bearing prominent plates; aperture round; operculum spiral, horny. Head has retractile proboscis; tentacles close together, with eyes at their bases; jaws toothed or spiny; radula elaborate. Sexes distinct. A creeping, carnivorous family of world-wide distribution, allied to Ianthinidæ.

Genus SCALA, Humph.

Characters of the family. Living species, 200; fossil species, 200.

The peculiar flanges that decorate these shells, making them resemble spiral staircases, are the successive limits of periods of growth. Each in turn has been the shell's lip until growth began again, and it was left behind. The genus has a wide distribution from arctic to tropical seas in eastern and western hemispheres, from low water mark to abyssmal depths. The West Indies have furnished the greatest number of species. Large species measure $2\frac{1}{2}$ inches in length; one species, 4 to 5 inches. When disturbed, the wentletraps exude a purplish fluid.

The **Precious Wentletrap** (*S. pretiosa*, Lam.) has had a romantic history. It was long considered a Chinese shell, but was later found also off the Australian coast and among the Moluccas. It is one of the largest known species, reaching $2\frac{1}{2}$ inches in length. It has a broad-based spire of eight roundish whorls, smooth and white, decorated with ivory white flanges or ribs that cross the whorls at regular intervals. The sutures are deep and the umbilicus wide. The mantle has a flaring rim.

About the year 1700 these shells attained an exorbitant and fictitious value in the estimation of shell collectors. Forty guineas (\$200) was paid for a single specimen. Fifty years later this price

was cut in two. The clever Chinese counterfeited the precious shells, too rare for their liking, by moulding them from a paste made of rice flour. Now the range of the species is found to be much less restricted than was supposed in the eighteenth century. A good specimen of *S. pretiosa* can be had of almost any curio dealer for a dollar or two.

The **Ladder Shell** (*S. Grænlandica*, Chemn.), Greenland to Massachusetts Bay, has been found abundantly in the stomachs of fishes taken on the Grand Banks and farther south. The shells are picked up on Nahant beach and on the Maine coast. They are graceful, turreted, heavy, with sharp spire of ten whorls, flattened, close-set, each bearing revolving ridges and crossed by oblique, prominent white ribs. The ground colour is brown or bluish. A rib, angled at the inner point, edges the round aperture.

The animal is yellowish gray, spotted with white. The foot is squarish and thick. The head is rounded above, elongated, with a shiny black eye at the base of each short tentacle. The large mouth eagerly seizes bits of fresh beef, when the mollusk is in an aquarium. Its movements are sluggish. Length, 1 inch.

S. lineata, Say, found from New England to Florida, is a thick little ladder shell ornamented with two brown spiral bands on the body whorl. The shell is elongated, with six or seven whorls, and regular cross ribs throughout its length. Length, about $\frac{1}{2}$ inch.

S. angulata, Say, with its ribs a bit angled next to the suture above, has six to ten whorls which do not touch each other in the coil. It is about $\frac{3}{4}$ inch long, rather stout and white. It occurs from Connecticut to Florida and Texas.

S. multistriata, Say, of our Atlantic coast, is known by the multitude of its ribs that crowd closer than in any other species. It is a solid white shell of graceful form. Length, $\frac{1}{2}$ to $\frac{3}{4}$ inch.

S. clathratula, Ads., found on European coasts, and from New England to Cape Hatteras, is a polished white, almost transparent shell, slender and graceful, about $\frac{1}{2}$ inch long. Its rounded whorls bear a great number of cross ridges.

On the west coast is found **S. Hindsii**, Cpr., a delicate white ladder shell, scarcely an inch long, with a needle point and rounded whorl crossed by many thin, sharp ridges. Professor Keep says these shells are mounted for ear drops, sometimes, by enterprising jewellers. Southern California.

S. Indiorum, Cpr., is found on the California coast and north to Vancouver Island. It is thin and white, an inch long, with numerous cross ribs on its ten whorls. Occasionally it is found in a variety, *tinctoria*, tinged brownish purple, in Southern California.

S. mirifica, a rare deep water species, I mention here because it is unique. It has the distinction of being the most highly coloured of all deep sea mollusks. As a rule abyssmal shells are dull and colourless. This notable exception is white, tinted with bright rose-colour.

CHAPTER XXIX: THE VIOLET SNAILS

FAMILY IANTHINIDÆ

SHELL spiral, helicoid, fragile, semi-transparent, violet-coloured, about $1\frac{1}{2}$ inches in diameter; no operculum; head prolonged into a large snout; radula very large; no eyes; tentacles short; gill feather-like; foot small, attached to a gelatinous float filled with air bubbles to which the egg capsules are attached. Sexes separate. A pelagic family of gregarious habit found in Atlantic and Pacific Oceans. One principal genus of three species.

Genus IANTHINA, Lam.

The Violet Snail (*I. fragilis*, Lam.) drifts in schools on the ocean's surface. Let us look into the life history of this delicate little sea snail.

The strangest thing about it is a family trait. The foot secretes a slimy substance which hardens in contact with water. As it is excreted, bubbles of air are captured by the extensible foot and imprisoned by the viscid exudation. So a series of pneumatic cushions unite to form the flat raft. On the underside of the float of the female the egg capsules are usually attached, neatly ranked in rows.

One by one the outermost capsules are ruptured and the little snails tumble out to take their chances in the great ocean. The raft is often found afloat without its mollusk. Storms wrench many apart. Fish nip off portions of the float; the foot may add more at the end next to the body. But a violet snail bereft of its float drops to the bottom, and has no power to rise to the surface. Moribund individuals let go their foothold on the raft, and die on the ocean floor. But active individuals from which the floats were cut loose by Mr. Arthur Adams reproduced them in the aquarium when they were suspended by hooks in a position just below the surface of the water.

Unhappily, many an ill wind drives the Ianthina swarm

shoreward. It occasionally happens that a purple band is painted on the beach, the shattered fragments of purple shells. Even those which escape breaking by the surf are unable to get back to their element because the foot is not adapted to such effort. The sun kills them and birds devour them. It is generally years before another school of *Ianthina* is wrecked on the same beach.

Violet snails are often met far off shore. But I fancy that only skilled observers would see the little fleet. The elongated raft is but a small group of bubbles on the surface. At one end of it the head and foot of the mollusk come nearly out of the water, but they look transparent. The mouth of the shell is turned upward, and the exposed outer whorl where the body lies is coloured a deep violet which blends with the deep blue of the sea. The apex is farther from the surface, and is a paler violet. The precious eggs are quite out of sight.

The chief enemies of the violet snail are sea birds that skim and scan the surface for food. Against them Nature has given this little creature adequate "protective coloration" to enable it to escape detection. It has no eyes, and the only defence it offers when disturbed is to exude a little cloud of violet ink.

For its food special provision is made. Small jelly-fishes which like the surface of the sea swarm in numbers so great that the violet snail has but to thrust out its prehensile proboscis to catch them.

Off our Florida coasts the genus *Vellela* abounds, each individual a cake of jelly, bright blue, transparent, hung below with short streamers and above hoisting a three-cornered sail. This is a hydroid colony, like the Portuguese man-of-war. The violet snail seizes one with its snout, and tears it to shreds with its remarkably large rasping tongue. It is a surprise to see so delicate a mollusk tackling a "jelly-fish" four or five inches long, and well provided with protective stingers.

Barnacles, which attach themselves to its shell, are occasionally eaten by *Ianthina*. A blue crustacean lives on the float, asking nothing of its host but lodging and free transportation. Some contend that the young of the violet snail, as they hatch, get on the raft of their mother and secrete little floats before they are equipped for life in the water. This is doubtful, for each is born with a swimming apparatus.

I cannot draw from my own experience a vivid picture of a stranded school of violet snails, but I here quote Mr. Charles T. Simpson's letter to the *Nautilus*, April, 1897:

I had collected for many years and in many countries, but had never found, perhaps, more than a dozen dead or broken shells. In January, 1883, I was on a schooner bound for Spanish Honduras, and we stopped at Key West, where I spent one of the most delightful weeks of my life gathering *Cylindrellas*, *Chondropomas*, *Cerions* and the beautiful *Orthalicus*, *Liguus* and *Bulimulus multilineatus* in the thick, thorny tropical scrub. We were to sail at noon on Sunday, but I could not resist the temptation to take one last look at the beach. So after breakfast I wandered out.

Before I came to the beach I noticed that as far as the eye could see it was a mass of the most intense, glowing violet colour, and on coming up to it I was astonished to find that this colour came from untold millions of *lanthinas* which had been washed up during the night, for when I left the beach the evening before at dusk not one was to be seen. To say that they lined the shore gives no idea of the truth. Everywhere, from below low water to highest tide mark they were piled up, in most places, over shoe-top deep, and in the hollows of the rocks one could have waded in among them up to his knees. Shell, animal and float were all a vivid purple, the richness of which soon fades in dead shells and preserved specimens.

There had been no storm, nothing but an ordinary breeze up from the south, and it is probable that an immense school had been drifting along, and where they struck the island some five miles in length, every one in that distance was stranded.

I had brought no basket nor sack nor anything to collect in, but I could not bear to go away and leave that vast bed of treasures without taking at least a few with me. I searched in vain for a box or tin can or piece of canvas, but I could find absolutely nothing. I took out my handkerchief, knotted the corners, and tried to pull out the animals from the shells, but the whole mass was so slippery, and the shells so frail that the latter invariably broke. So I filled the handkerchief with shells and all, as many as it would hold. Then I took off my straw hat and filled it, and that did not satisfy me, for as I wandered along I found so many finer specimens that I began to put them into my pockets, and I did not leave the shore until every pocket was bursting full. I had on a linen coat and white duck pants. The day was hot, and it seemed to me that those *lanthinas* melted. In a little while streaks of glowing violet began to show down my clothes. I felt a clammy, wet, uncomfortable feeling clear through to my skin, and my shoes were filled with the purple liquid. By the time I reached the city I looked like an Indian in war paint. I have no doubt that the people of Key West,

who were just going to church, thought I was a lunatic, and perhaps they were not far from right. At last I reached the schooner, took off and threw away my suit, which was utterly ruined, and got my precious mollusks into sea water to soak. Although at least half of them were broken, yet when I cleaned them I had the satisfaction of counting up over two thousand good shells.

When the wind blows this little sailor ashore, on Floridian, Mediterranean or Pacific Island beach, an increasing number of interested observers gather a few uninjured specimens to watch in the aquarium jar. Better opportunity still comes to the naturalist on a voyage of discovery. While one group is busy dredging for deep sea forms of life, another in a row boat, with dip-net and tin pail, may skim the surface and collect the small but wonderful pelagic mollusks. "The blind snail of the sea" is among the most interesting of the varied ocean fauna. On shipboard or in the ordinary seaside aquarium it is quite at home.

CHAPTER XXX: THE HAIRY-KEELED SNAILS

FAMILY TRICHOTROPIDÆ

SHELL thin, turbinated; spire elongated; the keeled whorls bearing an epidermal fringe of hairs; aperture roundish, angled below; lip sharp; operculum laminated; foot elongated; head broad; radula well developed; eyes on sides of tentacles.

Genus **TRICHOTROPIS**, Brod.

Characters of the family. Fifteen species in arctic waters.

The **Northern Hairy-keel** (*T. borealis*, Brod. and Sby.) has a thin little colourless spire, an inch long or less, with strongly keeled whorls separated by deep but narrow sinuses. In life there is a thin brownish epidermis which bears a row of hairs. Dead specimens soon lose these hairs.

Habitat.— Japan, Northern Europe, Greenland to Massachusetts.

T. cancellata, Hds., a trifle larger, checkered by longitudinal ribs crossing the spiral ones, may be but the western form of *T. borealis*.

Habitat.— Alaska to Vancouver Island.

CHAPTER XXXI: THE SCREW SHELLS TOWER SHELLS

FAMILY TURRITELLIDÆ

SHELL a long slender spire of many whorls with revolving striæ and fine, curved lines of growth; mouth oval, or four-angled; lip thin; operculum spiral, horny; head with broad snout; eyes on bases of long spreading tentacles; mantle edge fringed; gill plume long, single; foot short, truncate in front, narrowed behind, grooved underneath. A marine family.

Genus **TURRITELLA**, Lam.

Characters of the family. Four hundred fossil and one hundred living species, chiefly in the Old World. Very few on American beaches. A peculiarity of this genus is that the upper fourth of the shell is always empty and divided by a septum at each half-turn.

The **Great Screw Shell** (*T. terebra*, Linn.) has a most elegantly turned spire, tapering to a needle point, its sixteen whorls strongly grooved and ridged as if done in a lathe. The pale surface is stained with orange, or clouded all over with fulvous brown. The largest ones I have seen are five inches long, with a breadth at base of more than one inch. The same proportions hold in the smaller specimens. They come from the Philippine Islands.

The idea of the screw was suggested to the philosopher Archimedes by the spiral shell of *Turritella terebra*.

The **Marbled Tower Shell** (*T. marmoratus*, Keiner) is an obelisk of many flattened whorls, finely marked with growth striæ. It tapers but little, and the apex is blunt. The surface is clouded and reticulated with lurid chocolate shades. Length, 6 to 8 inches.

Habitat.—Philippines.

The **Girdled Screw Shell** (*T. cingulata*, Sby.) is a slim

The Screw Shells. Tower Shells

"lady's finger," china-like in texture, highly polished, and wound with a series of narrow stripes in shades of brown on a white foundation. Length, 2 inches.

Habitat.—Peru.

The **Variegated Tower Shell** (*T. variegata*, Linn.) is clouded and streaked with chocolate colour upon a solid creamy white, china-like surface, and finely sculptured with revolving ridges. "Lady fingers" the children call these elegant shells which taper to a needle point. The sixteen flattened whorls are separated by narrow sinuses. Length, $2\frac{1}{2}$ to 5 inches.

Habitat.—Southern Florida, West Indies.

Cooper's Tower Shell (*T. Cooperi*, Cpr.), two inches long, yellow, streaked and spotted with brown, with a wide sinus, and two strong ridges on the whorls, is found on sandy beaches in Southern California when the tide goes out. This is a prime favourite with children.

T. acicula, Stimps., very thin and white and three-fifths inch long, is found in the stomachs of cod and other fish from Cape Cod northward. It has ten very convex whorls, each strongly ribbed. Other species have been collected by fish on our northeast coast, and have come into the hands of scientists. Of these so very few specimens are known that they are not to be found in ordinary collections.

CHAPTER XXXII: THE WORM SHELLS AND POD SHELLS

FAMILY VERMETIDÆ

SHELL tubular, with septa; regularly spiral when young; whorls free, irregular when adult; aperture round; operculum circular, concave on outside; body worm-like; head long, with tentacles and eyes; foot rudimentary. Mollusks usually attached to coral rocks or imbedded in sponges.

Genus VERMETUS, Ads.

Shell irregularly spiral, attached on one side or free; tube partitioned repeatedly; operculum small.

The **Worm Shell** (*V. spiratus*, Phil.) is a mollusk, notwithstanding its very worm-like shell, which is yellowish brown, or white, like the calcareous coverings of certain marine worms. The spiral is close and regular at first, then it becomes free and wanders off in irregular, wayward fashion. Longitudinal, angled keels on the shell, distinguish this species. It may attain a length of 6 to 10 inches. To fit the attenuated shell, the body is much elongated. The foot is short and broad. There is a horny circular operculum fitting the aperture. The toothed tongue is truly molluscan.

These shells often form, as if for mutual protection, an intricate, tangled mass. They are found in shallow water all along the Atlantic seaboard, in the West Indies and the Gulf of Mexico.

V. squamigerus, Cpr., occurs in clusters on the southern California coast. Each shell is loosely twisted, and shows scaly growth lines. Colour, yellowish white.

V. varians, d'Orb., forms masses on the Florida coast. The shells are irregularly convoluted, and violet brown.

Genus SILIQUARIA, Brug.

Shell spiral, becoming free and irregular, with a longitudinal groove, or series of holes, its whole length; operculum elevated

The Worm Shells and Pod Shells

and spiral outside. Mollusks live on coral rock or sponges on tropical shores.

The **Pod Shell** (*S. anguina*, Linn.) is like the spirally twisted pods of certain leguminous plants. The long open groove in the shell distinguishes it from the worm shell. This species begins as a close spiral, but soon becomes irregular. It is a heavy yellowish shell, cylindrical, 3 to 6 inches long, and one-half inch in diameter at its mouth. It is found imbedded in sponges.

Habitat.—Mediterranean Sea.

S. modesta, Dall, unmistakably a pod shell, occurs in deep water from Cedar Keys, west coast of Florida, through the West Indies.

CHAPTER XXXIII: THE BLIND SHELLS. TUBE SHELLS

FAMILY CÆCIDÆ

SHELL minute, tubular, spiral at first, but becoming merely cylindrical, often losing the spiral part; one or more septa in posterior end of shell; foot short, bearing horny operculum; mantle thick, fleshy, circular; tentacles bear eyes; gill single. An interesting family of one genus of small mollusks inhabiting warm seas.

Genus CÆCUM, Flem.

The strange development of this mollusk has been recently investigated. "In the young of *Cæcum* the apex is at first spiral but as growth proceeds and the long tube begins to form, a septum is produced at the base of the apex, which soon drops off. Soon afterwards, a second septum forms a little farther down, and a second piece drops off, leaving the shell in the normal cylindrical form of the adult."—*Cooke*.

Much confusion has been caused by conchologists who classified members of this genus at different stages of development in widely separate groups because they had no knowledge that such changes of form occur in the life history of the individual.

The **Florida Blind Shell** (*C. Floridanum*, Stimps.) is a curved white horn of about thirty-two narrow rounded whorls. The sinuses are wider than the rings. The posterior end is closed with a septum bearing a sharp point. The mouth is oblique. Length, $\frac{1}{4}$ inch.

Habitat.—Cape Hatteras to Florida.

C. pulchellum, Stimps, $\frac{1}{8}$ of an inch long, brownish, with twenty-five rings and a blunt posterior septum, comes from New Bedford, Mass., and neighbouring beaches.

This "pretty blind shell" reveals its exquisite structure under the microscope, though no larger than a grain of rice. It does not escape the eye of the collector who is out for small

The Blind Shells. Tube Shells

snails. A quantity of this species was uncovered in dry sand under a piece of driftwood on the beach at the extreme end of Long Island.

It is incomprehensible to some people that grown-up men can spend time searching for shells so small they are scarcely visible to the unaided eye. "Too small to putter with," is the ultimatum. Such people cannot understand the fact that to the mind that grasps the limits of the great animal group, Mollusca, no family, however small in size or scope, is insignificant. In fact, each species and variety is big with meaning. It is only small people who fail to grasp this fact. Only the ignorant can think the naturalist, in the field or the laboratory, is wasting time.

C. crebricinctum, Cpr., is red-brown, with dark streaks running lengthwise across the eight close rings. The tip is pointed. Length, $\frac{1}{8}$ inch.

Habitat.—Southern California.

C. Californicum, Dall, is a narrow curved shell with very fine rings. Length, scarcely $\frac{1}{16}$ inch.

Habitat.—San Diego, Cal.

C. Cooperi, Smith, $\frac{1}{4}$ inch long, is cross ridged, which gives it considerable beauty under a lens. It is found in New England and off Long Island.

C. nitidum, Stmps., is a very swollen form contracted at both ends; the shell is shiny and pale brown. Length, $\frac{1}{16}$ inch.

Habitat.—Florida.

CHAPTER XXXIV: THE EULIMAS

FAMILY EULIMIDÆ

SHELL small, porcellanous, white, polished, with slender spire; aperture oval; foot elongated; proboscis long, retractile; jaws and radula wanting. A little-known family of small mollusks parasitic on bivalves, sea-urchins and sea-cucumbers.

Genus EULIMA, Risso

Characters of the family. Spire often curved to one side. Foot secretes a mucous filament which helps the mollusk to float.

The patient host must feed itself and its parasites, which, having no chewing organs, suck liquid food from the bodies they live upon. One species which lives on the outside of a sea-cucumber is seen to have no foot developed; it is fixed to one spot as if planted. But this one has developed a proboscis three times as long as the body; the tip of this flexible organ explores the surface for as great a distance as possible, taps the skin, and sucks the cucumber's blood. Another species is parasitic on the stomach wall. It moves about on a large foot and has a very short proboscis. From arctic to tropic seas these little pests are found; some species are found attached to bivalve shells, others to the opercula of univalves.

The **Shining Eulima** (*E. micans*, Cpr.) is bluish white, a glistening, slender, straight spire about two-fifths of an inch long, with a small oval mouth. Vancouver Island to San Diego, Cal.

E. intermedia, Cantraine, one of the few east coast species, is $\frac{1}{3}$ to $\frac{1}{2}$ an inch long; its slender, semi-transparent spire is tinged with brown. The body whorl is elongated.

Habitat.—Europe and United States, on Atlantic coasts.

E. candida, Marrat, is a good illustration of the family peculiarities of form which our native species do not emphasise. The oblique line of varices down from the spire show where the mouth was at successive stages of growth. The spire is bent slightly. Colour, white. Length, 1 to 2 inches.

Habitat.—Island of Formosa.

CHAPTER XXXV: THE PYRAMID SHELLS. OBELISK SHELLS

FAMILY PYRAMIDELLIDÆ

SHELL slenderly spiral, of many whorls, coiled to the left; aperture entire; columella with one or more folds; operculum horny; foot extending far beyond head; proboscis long, retractile; radula wanting; tentacles flattened, ear-shaped, channeled outside.

This family includes but one genus in which living species exist. They are believed to be carnivorous, despite the deficient mouth parts.

Genus PYRAMIDELLA, Lam.

Characters of the family. Tropical seas.

The **Obelisk Shell** (*P. conica*, C. B. Ads.) is our representative of this genus. It occurs in Florida and at San Diego, Cal. Its ten flat whorls are separated by a deep spiral suture. It has a slender brownish spire half an inch high. Three folds are seen on the columella. This shell is rare.

Genus TURBONILLA, Leach

Shell minute, awl-shaped, its many whorls crossed by sharp, close ridges, columella straight, outer lip thin, simple.

A very large genus of very small pyramid shells, widely distributed, chiefly in warm seas.

The **Short Pyramid Shell** (*T. curta*, Dall) is a *Cerithium* in form, but its daintily cross-ridged spire is but one-third of an inch long.

Habitat.—Cape Hatteras southward.

The **Chestnut Turbonilla** (*T. castanea*, Cpr.), with the

characteristic cross ridges on its ten flat whorls, is a rich brown on the outside. Length, $\frac{1}{2}$ inch.

Habitat.—California.

Genus ODOSTOMIA, Flem.

Even smaller than the preceding genus, which it resembles in form, in most cases a trifle stouter and with a tooth-like fold, always, on the curved columella. Animal lives on slimy excreta of other mollusks, or on polyps and sponges of small size. The shells are white and lack cross-sculpture.

O. impressa, Say, is regularly conical but slender, its spire wound with close, grooved lines. The lip flares around an oval aperture. Length, $\frac{1}{3}$ inch.

Habitat.—Massachusetts Bay to West Indies, West Florida.

CHAPTER XXXVI: THE PERIWINKLES AND CHINK SHELLS

FAMILY LITTORINIDÆ

SHELL spiral, turbate or globular, not pearly; aperture oval or circular, entire; lip simple; columella thickened, flattened; operculum horny, of few coils; snout wide, short; eyes on swellings at outer bases of the long tentacles; foot broad and square in front and behind, divided lengthwise; radula long and narrow. Reproduction by eggs hatched within or outside the body.

Genus LITTORINA, Fér.

Characters of the family. A large genus of 150 species, living on rocks between tide marks. Some live in brackish, some in fresh water. Some species are amphibious and can survive long periods of drought. Some live on aerial roots of mangrove trees, where they overhang the water and get the dash of its spray. The distribution of the genus is world-wide. It is rapidly spreading on American coasts.

Periwinkles furnish an important article of food to European markets, where they are bought by the poorer and middle classes. They are also an important bait for fish.

The **Shore Periwinkle** (*L. littorea*, Linn.) is a mollusk fitted by nature to survive in the struggle for existence. Abundant on all the shores of Northern Europe, it has colonised New England and is rapidly extending its range southward. Its solid shell and horny operculum make an impregnable fortress against foes without.

The name periwinkle, is an old one. It is supposed to be modified from "petty winkle," the small one, to distinguish it in the London markets from the large winkle, or whelk, *Buccinum undatum*. Both are staple foods in England. Thousands of tons of this dingy little mollusk are collected each year for the city trade by women and children on the rocky coasts of the British

Isles, and sold from corner stalls or push carts in the streets. They are used as food in other European countries. The Portuguese of Provincetown and other points on Cape Cod gather them in quantities.

An immigrant from England, this species has come to our coasts via Iceland and Newfoundland. Its invasion has rapidly progressed southward past Cape Cod and Long Island to the New Jersey beaches. On the rocky coasts of Maine it is found in greatest abundance, covering the sides of huge boulders and wharf piers exposed by the outgoing tide, clinging to seaweeds and stems of marsh grass, or crawling in ditches, and tide pools.

The shells are brownish yellow to olive or gray, sometimes spirally banded with dark red and brown. Sometimes they are black. There is great variability of colouring. They are thick, with seven or eight whorls, ribbed spirally. There is no umbilicus; the lip is thin and black; the columella broad and white. The aperture is round; the operculum horny. The spire is sharp, but the shell has a squat shape, the base and height are each about $\frac{3}{4}$ inch. The males are smaller than the females.

The periwinkle is a vegetarian, as are nearly all round-mouthed snails. Coiled inside the mouth is the radula or rasping tongue, about three times as long as the body ($2\frac{1}{2}$ inches); it has six hundred rows of sharp, curved, tricuspid teeth, seven in each crescentic row. Here is the weapon for scraping off the algæ which grows on rocks near shore. Knowing their feeding habits, the owners of oyster beds scatter periwinkles on their acreage to keep the hindering algæ grazed close.

The gait of the periwinkle is slow and uneven, one side of the foot moving forward as the other holds fast: another good instance of a "snail's pace." A median line divides the foot lengthwise into two areas which act alternately in walking. A gland in the foot secretes copious slime. The eggs are laid in masses on seaweeds or rocks.

The **Common Periwinkle** (*L. irrorata*, Say) is a heavy, sharp-pointed conical shell, of a few finely ridged whorls. Numerous chestnut dots, in spiral lines, give a brownish colour to the exterior; the smooth columella is also brown. The lip is thick but bevelled suddenly to a thin edge and dotted with brown. This is the periwinkle of the Gulf of Mexico, which has gradually progressed northward for years, overlapping the range of the less robust

L. littorea. We look for both species on rocks between tide marks, and in stagnant pools and marshes. They seem to avoid the dash of the surf, though they are built to resist harm from wave action. Length, 1 inch.

Habitat.—Florida to New York.

The **Rough Winkle** (*L. rudis*, Don) is at best scarcely half an inch in length, with rounded whorls separated by deep sutures. The female carries her eggs until they hatch, hence the last whorl is fully two-thirds of the whole shell and the round mouth is much larger than that of a male shell of equal size. This species is banded in neutral colours, from yellow to black. It can live out of water for a week. Marked specimens on the rocks were found not to have moved for over a month. The shells of the young brood render these periwinkles inedible. Their size, also, makes them hardly worth while. Length, $\frac{1}{8}$ to $\frac{1}{2}$ inch.

Habitat.—Atlantic and Pacific coasts.

The **Gray Littorina** (*L. planaxis*, Nutt.) is known by the broad, flat excavation of the columella. The shells are smooth rather thick, dirty white, flamed in irregular, often handsome patterns. The young shells lose their brightness with age. The average diameter is $\frac{1}{2}$ inch.

Habitat.—California.

The **Checkered Littorina** (*L. scutellata*, Gld.) is brown or olive, checkered with white. The average shells are $\frac{1}{2}$ inch or less in length. It is a very variable species.

Habitat.—West coast of United States.

The **Zigzag Periwinkle** (*L. zigzac*, Dillw.), has a tall spire, angled at its periphery, and decorated with fine, zigzag stripes of brownish yellow from apex to base. The body whorl shows a median clouding of blue that is faintly seen on the upper whorls. The species is variable. Length, $\frac{1}{2}$ to 1 inch.

Habitat.—Texas, Florida Keys, West Indies.

L. angulifera, Lam., is distributed on the Florida and Gulf coasts and in the West Indies.

Genus TECTARIUS, Val.

The **Pagoda Littorina** (*T. Pagod*, Linn.) is very much like a Chinese pagoda, with a row of upturned, triangular tubercles finishing the keeled margins of its whorls. Secondary tubercles

in oblique rows cross the spaces intermediate between the keels, and granulations cover the whole surface. The body whorl has a double set of strong tubercles and a smaller row between these. The simple aperture is ribbed inside and tinted with the pale chestnut that stains and streaks the colourless exterior. Altitude, $2\frac{1}{2}$ inches.

Habitat.—Australia, Ceylon.

The **Prickly Littorina** (*T. muricata*, Linn.) has a solid, yellowish gray shell with rounded whorls a little flattened below the sutures and beaded with sharp nodules along the spiral ribs. The aperture is nearly smooth, and brownish. This creature has lived a year in a cabinet, cheerfully taking up its aquatic life again when released. Length, 1 inch.

Habitat.—Bahamas, West Indies, Florida.

T. nodulosus, Gmel., is smaller, $\frac{1}{2}$ to $\frac{3}{4}$ inch long, dull olive green or brownish yellow, spirally double-keeled and beaded, with aperture smooth and brown. This "worthless Littorina," as Reeve calls it, has a world-wide distribution.

Habitat.—North Carolina to West Indies, Ceylon, Philippines, Australia.

THE CHINK SHELLS

Genus LACUNA, Turton

Shell thin, ovate, turbate or round, covered with epidermis; aperture half-moon shaped; columella with groove or chink leading to umbilicus; lip sharp; operculum thin, spiral.

The **Atlantic Chink Shell** (*L. vincta*, Turton) looks at first glance like an elongated and thin specimen of Littorina. The spire is smooth, horn-coloured, or banded with brown on a purplish ground. The distinctive generic feature is the deep columellar groove. It lives upon seaweeds in sheltered coves, and is often quite as well represented as the periwinkles in the debris of an inshore wind. Length, $\frac{1}{2}$ inch.

Habitat.—Arctic seas to New Jersey.

The **Chink Shell** (*L. porrecta*, Cpr.) has a wide groove, and the body whorl is much enlarged. The creature is found on seaweed. It is about $\frac{1}{2}$ inch in diameter.

Habitat.—Vancouver Island to San Diego, Cal.

L. variegata, Cpr., streaked with chestnut, often beaded with white on the peripheral margin, has about the same distribution, but is one-half as large as *L. porrecta*.

L. pallidula, Da C., with widely flaring mouth and wide umbilicus, is a yellowish species found in the North Atlantic. It is about $\frac{1}{2}$ inch in diameter.

Habitat.—New England.

L. divaricata, Fab., is a glossy little chink shell, with elongated spire, whitish, often variously banded with brown and white. Length, about $\frac{1}{2}$ inch.

Habitat.—All cold waters of northern hemisphere, including New England and northwestern coast.

Genus MODULUS, Gray

Shell top-shaped, solid; whorls grooved and tubercled; umbilicus narrow; columella grooved, ending below in a sharp tooth. Few species.

The **Florida Modulus** (*M. Floridanus*, Conr.) has a depressed spire, strongly ribbed, and crossed above the periphery by short, oblique nodular ridges. The umbilicus and the sharp tooth of the columella are the best distinguishing features. Its colour is dirty white, often tinged with brown or olive green. Diameter, $\frac{1}{2}$ to $\frac{3}{4}$ of an inch.

Habitat.—West coast of Florida Keys.

Genus FOSSARUS, Phil.

Shell small, spiral, compact, ridged, with umbilical groove on the columella. Littorine mollusks on seaweeds.

The **Elegant Fossarus** (*F. elegans*, Verr.) has its few coils most beautifully sculptured with strong winding ridges crossed by deeply chiseled, close striations. The large, round mouth crowds the grooved columella and almost covers the pit. The outer lip is frilled. Length, $\frac{1}{8}$ inch.

Habitat.—Rhode Island to Cape Fear.

F. obtusus, Cpr., is a light brown, round shell, with spiral grooves that crimp the lip of the oval aperture. The umbilical chink is present, though small. Length, $\frac{1}{4}$ inch.

Habitat.—California.



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UNIVALVE SHELLS OF TROPICAL SEAS

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|----|---|----|--|
| 18 | Open Melongena, <i>Melongena patula</i> , B. and S. | 22 | Little Red Triton, <i>Triton rubecula</i> , Linn. |
| 19 | Fighting Melongena, <i>Melongena pugilina</i> , Born. | 23 | Nicobar Spindle Shell, <i>Fusus Nicobaricus</i> , Chemn. |
| 20 | Leafy Frog Shell, <i>Ranella foliata</i> , Brod. | 24 | Melongena, <i>Melongena melongena</i> , Linn. |
| 21 | Rudolph's Purple, <i>Purpura Rudolphi</i> , Linn. | 25 | Triton, <i>Triton aquatilis</i> , Rve. |

CHAPTER XXXVII: THE HORN SHELLS

FAMILY CERITHIIDÆ

SHELL spiral, much elongated, of many whorls, surface tuberculated; aperture channeled in front; operculum horny, spiral; the head bears short muzzle, slender tentacles and stalked eyes. A large family of tropical and sub-tropical mollusks, living on rocks or among marine vegetation. A few forms live in brackish and fresh water. Some spend much time out of water, on stems of marsh plants.

Genus CERITHIUM, Brug.

Shell turreted, imperforate, varices indistinct; aperture small, with short posterior canal, the longer, anterior one oblique; outer lip expanded; inner lip thickened, concave. Siphon short; body grooved, truncated in front, narrowed behind; foot secretes a thread by which body may be suspended. It is often attached to a piece of floating seaweed. When unattached the mollusk crawls quickly along by its slender, extensible foot. It emits a green fluid when disturbed. It feeds on all sorts of decaying organic matter, even the slime of snails. Fossil species, near five hundred. *C. giganteum*, an Eocene fossil, is two feet long. American representatives few and of small size. Marine or amphibious mollusks in tropical seas, with a few in temperate waters. In the West Indies they swarm in great numbers and variety. One species is the sole food of flamingoes after they attain adult size. One sweep of a hand-net in the tide pools at low water on the reefs just out of Key West will gather in hundreds of them, particularly of the species *septem-striatum*, Say. There are hundreds sunning themselves on every exposed rock.

The **Brown Horn Shell** (*C. eburneum*, Brug.), about 1 inch long, has strong spiral ribs set with rounded knobs, the middle ridge bears the largest. Fine spiral striæ and occasional varices

The Horn Shells

further sculpture the surface. Chestnut dots and patches colour the depression and the aperture. Sometimes the shells are colourless.

Habitat.— West Indies, Florida.

The Dark Horn Shell (*C. atratum*, Born.) has a row of small nodules in the suture, and a larger row on the keel of the whorl, with fine striæ between. A strong varix is opposite the aperture. Colour, dark gray or chocolate; aperture bluish. Length, 1 to 1½ inches.

Habitat.— West Indies, Florida.

C. muscarum, Say, has rounded, spirally ribbed whorls crossed by longitudinal, finely knobbed, ridges. Small brown dots cover the more depressed surfaces and often the ridges as well. This is a slender species. Length, 1 inch.

Habitat.— Bahamas, Florida.

C. litteratum, Born., is a stouter shell, 1 to 1½ inches long, its whorls bordered above with the strongest set of tubercles, the depressed surfaces dotted and splashed with pale brown, in a pattern resembling letters.

Habitat.— West Indies, Florida.

C. ferrugineum, Say, is two-thirds of an inch long, dark with orange red tinge, spirally ridged and faintly knobbed, with a dark aperture.

Habitat.— South Carolina to Florida.

C. læve, Quoy, a smooth species, is the largest living member of the family. It is white with many flattened whorls forming a regular spire, except that the body whorl is slightly swollen. Length, 5 to 6 inches.

Habitat.— Australia.

Genus CERITHIDEA, Swains.

This group is distinguished by the tree-dwellers and other amphibious forms it contains.

The **Decollated Cerithidea**, (*C. decollata*, Linn.), the type of the genus, is a widely distributed species of robust character, somewhat over an inch long. The apex is truncated, the rounded whorls brown, sometimes with a white line at the suture, with strong ridges and fine striæ crossing all over the surface. These mollusks live on swampy coasts of warm regions. They some-



PERIWINKLES AND WORM SHELLS

1 *Littorina litorea*.
2 *Littorina irrorata*.

3 *Littorina angulifera*.
4 *Littorina planaxis*.

5 *Pyramidella conica*.
6 *Siliquaria anguina*.

7 *Tectarius pagodus*.
8 *Vermetus spiratus*.



HORN SHELLS

1 *Cerithium nodulosum*
2 *Potamides palustris*

3 *Telescopium fuscum*.
4 *Potamides sacrata*.
5 *Potamides ebeninus*.

6 *Vertagus maculosus*.
7 *Cerithium laeve*.

times cover the trunks of marsh trees in Natal so thickly that not an inch of the bark is unoccupied. A naturalist who collected them at this station says that the mollusks are attached by a trifle of brittle mucus that affixes the lip to the tree. None hangs by a thread.

Habitat.—Madagascar and India.

C. scalariformis, Say, resembles a staircase shell (*Scala*), as its whorls are crossed by a multitude of distinct longitudinal riblets. It is an inch long, whitish to chocolate-coloured. In the dark shells the ribs are white. It habitually crawls up grass stems, and stays most of the time out of water.

Habitat.—Florida.

Genus POTAMIDES, Bron.

Shell imperforate, turreted, angled, tubercled or spiny, with thick epidermis, apex often decollated; operculum horny; foot nearly circular, blunt behind; siphon fringed. A genus of tropical brackish water species which are able to live for long periods suspended above the water by threads spun from the foot.

A species, **P. palustris**, Brug., lives in the salt marshes of the Eastern Archipelago. The natives collect these in quantities for food. They are roasted, then the contents of the shell are sucked out, the spire being broken off first.

In Borneo the large **P. telescopium**, Brug., 8 to 10 inches long, is an article of food. Near Calcutta this species is so abundant that the shells are burned for lime. The live mollusks are first heaped in the sun to die.

P. sacrata, Gld., has a narrow, dark brown spire, with rounded whorls marked with spiral ridges and crossed by longitudinal ridges and occasional stronger varices. It is abundant on muddy flats at low tide. Length, 1 to 1½ inches.

Habitat.—California.

Genus BITTIUM, Leach

Shell elevated; whorls many and granular, with irregular varices; anterior canal short, not recurved; outer lip not reflected, usually with an exterior rib; foot narrow, square in front. Small mollusks, in temperate seas.

The Horn Shells

B. filosum, Gld., has about eight whorls, each lined with four ridges, forming a graceful spire, $\frac{1}{3}$ to $\frac{2}{3}$ of an inch long. It is thin, of horny texture, brownish to white, and found attached to stones at low tide. Small hermit crabs often take possession of the dead shells. Sitka to Monterey, Cal.

B. nigrum, Totten, is $\frac{1}{3}$ inch long, a chocolate-coloured conical shell, cross-banded by spiral and longitudinal ridges, of which the spiral only persist on the the base of the body whorl.

Habitat.—New England to Florida.

B. quadrifilatum, Cpr., has four raised lines on the convex whorls of its graceful slender spire. Length, about $\frac{1}{3}$ inch.

Habitat.—Southern California.

Sub-Genus CERITHIOPSIS, Forbes and Hanley

Shell small, rather cylindrical, narrow, tubercled; whorls numerous, narrowing toward base; aperture small; canal short, straight; foot narrow. Inhabits northern and temperate seas.

C. punctata, Linn., is a little brown shell, paler on the ridges, which intersect, making the surface finely granulated. The body whorl has a smooth concave base. Length, $\frac{1}{2}$ to $\frac{3}{4}$ inch.

Habitat.—Massachusetts to Florida, West Indies.

C. tubercularis, Montg., is the European horn shell found also in Florida and on the west coast of North America. It is half an inch long, however, in the New World form, twice as large as the European type. It is a dark brown shell with three rows of strong, regular tubercles. The sutures are well marked, the apical whorls smooth.

Habitat.—Europe, Vancouver Island to Southern California.

C. purpurea, Cpr., has whorls in which the upper half is dark brown, the lower half paler. Three series of nodules coil from base to spire. Length, $\frac{1}{3}$ to $\frac{1}{2}$ inch. California.

C. terebralis, C. B. Ads., has a narrow spire sculptured with sharp spiral ridges, three on each whorl. Chocolate brown solid colour is tinged with yellow. Length, $\frac{1}{3}$ to $\frac{2}{3}$ inch.

Habitat.—Massachusetts to West Indies.

Genus TRIFORIS, Desh.

Shell spiral, elongated, granular, coiled to the left, whorls numerous, aperture small with short canal. One hundred species.

Peculiar in retaining the larval form until quite large, especially when living far from shore.

T. decorata, C. B. Ads., is white overlaid with checkers of dark brown. The whorls bear three rows of beads with deep channels between. The "left-handedness" of this slim little shell makes it noticeable. Length, $\frac{1}{2}$ to $\frac{3}{8}$ inch.

Habitat.—Florida, West Indies.

A Californian form of the European *T. perversa*, Linn., is var. *adversa*. Its ribbed and beaded, yellowish brown spire coils to the left, distinguishing it from other genera of the horn shells. It is about the same size as *T. decorata*.

CHAPTER XXXVIII: THE BLACK SNAILS. MARSH SNAILS

FAMILY MELANIIDÆ

SHELL spiral, turreted; spire often worn; epidermis dark, thick; aperture notched or chambered in front; outer lip sharp; operculum horny, spiral.

Animal with broad, short, foot; broad, non-retractile snout; tentacles far apart, bearing short eyestalks; tongue long, slim, with seven series of many-cusped teeth; mantle margin fringed; gill of stiff, cylindrical plates. Reproduction often viviparous.

A large family inhabiting fresh water lakes and rivers, in warm regions, chiefly of the Old World.

Genus **MELANIA**, Lam.

Shell with acute apex, its whorls ornamented with spines or striations; aperture oval, pointed above. Four hundred species, distributed over Southern Europe, India, Philippines, Pacific Islands, in swift tidal rivers, especially in rapids.

The Melanias include forms with cancellated, tubercled and smooth shells. They range from globose to needle-like forms. The largest is under three inches long. Many species have their shells decollated — broken off at the apex. The finest species are Philippine.

The **Acorn Black Snail** (*M. glans*, Busch) is smooth, oval, olive-hued, with a depressed spire; the body whorl and the aperture are both very large. Length, 1 inch.

Habitat.— Java, Philippines.

The **Bristly Black Snail** (*M. setosa*, Swains.) is globose and has its spire set with a spiral row of erect sharp spines. The black or green exterior contrasts with the pale lip and throat. Length, 1½ inches.

Habitat.— Philippines, Fiji Islands.

M. hastula, Lea, is fawn-coloured and long and tapering

like the auger shells. Its whorls are few, cross-ribbed and somewhat rounded. Length, 2 to 3 inches.

Habitat.—Philippines.

M. lævissima, Sby., is a solid, stout, smooth, conical shell, thick-lipped, ashy blue streaked with purple. Length, 1 to 2 inches.

Habitat.—Mexico.

Genus PALUDOMUS, Swains.

Shell conical or globose; aperture large, round; peristome continuous; columella callous; operculum spiral; animal like Melania. Twenty-five species, found in India and Ceylon.

Gardner's Paludomus (*P. Gardneri*, Rve.) is the most characteristic species. The orbicular-ovate shell is deeply sculptured by blunt, spiral ridges, alternately large and small; the mouth is large, the spire depressed; colours, black outside, white inside, with purple-stained lips. Length, $1\frac{1}{2}$ inches.

Habitat.—Ceylon.

The **Mail-Clad Paludomus** (*P. loricatus*, Rve.) is a stony, globose shell, wide mouthed like a Nerite, which it otherwise closely resembles. The revolving ribs are set with triangular points, like diminutive shark's teeth. The brown exterior contrasts sharply with the white interior. Length, $1\frac{1}{2}$ inches.

Habitat.—Ceylon.

CHAPTER XXXIX: THE RIVER SNAILS

FAMILY STREPTOMATIDÆ

SHELL turreted or ovate; aperture angled or channeled in front; epidermis olive-hued; operculum sub-spiral; mantle not fringed. An oviparous group of five hundred species, confined to the United States except for a few West Indian species. They are found chiefly in the headwaters of streams rising in the mountains of the south central states.

Genus IO, Lea.

Shell tuberculated, with few exceptions; spire elevated; peristome flaring; canal twisted; columella smooth, concave. Few species in rivers of Tennessee and West Virginia,

The **Spiny Io** (*I. spinosa*, Lea) is the most graceful of these tuberculated fusiform shells, quite as beautiful in form as the spindle shells it resembles. Under the horny epidermis obscure purplish bands appear on an olive ground. The aperture is half as long as the shell. Length, 2 inches.

Habitat.— Virginia, Tennessee.

The prominence of the tubercles makes this species pre-eminent among American river snails, and leads to their being mistaken for marine mollusks. Specimens found in Indian graves were called "conchs" by their discoverers, who argued that the tribes must have once lived near the shore. But no such shells occur in salt water.

The **River Io** (*I. fluviatilis*, Lea) is smooth or faintly knobbed, solid, greenish, stained with purple. The canal is scarcely twisted and has a rounded end. Length, 1 inch.

Habitat.— Tennessee region.

I. inermis, Anthony, is unarmed. The smooth, elegantly fusiform shell is purplish throughout. Length, 2 inches.

Habitat.— Southern States.

The **Turreted Io** (*I. turrita*, Anthony) is more elongated

than *I. spinosa*, which it imitates in its decoration of stout spines. Two faint bands traverse each whorl. Length, $2\frac{1}{2}$ inches.

Habitat.—Tennessee.

I. brevis, Anthony, is stout and short, with stubby spines, five on the keel of each whorl. The canal is broad, but short. Length, 2 inches. Tennessee.

Genus **ANGITREMA**, Hald.

Shell conical, spiny; canal short; aperture angled; columella thickened above and below. About twelve species in Tennessee and neighbouring states.

The **Knotty Angitrema** (*A. geniculata*, Hald.) is stout, solid, almost globular, with a row of round knees on the angled shoulder of the whorls. The flaring aperture is notched at both ends. The double callus on the columella is a noticeable generic trait. Colour, yellowish olive. Length, $\frac{3}{4}$ inch.

Habitat.—East Tennessee.

The **Armed Angitrema** (*A. armigera*, Say) is cone-shaped, with flattened and wrinkled whorls, and tubercled on a central keel. This row of knobs is buried by the revolving lip as it grows, though their presence is discoverable just below the sutures. The horny surface is often eroded at the apex; revolving red lines obscurely mark the whorls. Length, 1 inch.

Habitat.—Tennessee, Indiana, Kentucky.

Dutton's Angitrema (*A. Duttoniana*, Lea) is a handsome species. The elegant yellow-banded spire is conical, pointed, twice as high as wide. The long aperture is notched above and below. A row of tubercles usually follows the middle of the body whorl. Sometimes there is a keel instead. Length, 1 inch.

Habitat.—Tennessee rivers.

A. verrucosa, Raf., is ellipsoid, with blunt apex and long aperture; the lower whorl only is set with several rows of prominent warts. The outer lip is plaited within. Colour, olive brown, with white lining. Length, $\frac{3}{4}$ inch. Ohio River.

Sub-Genus **LITHASIA**, Hald.

Shell small, oval or short, fusiform, smooth; columella as in Angitrema; no distinct channel. Fourteen species, inhabiting rivers of the Tennessee region.

The River Snails

The **Dilated Lithasia** (*A. dilatata*, Lea) spreads out its white lips below the oval, yellowish green spire, showing the brown lining. Low tubercles are sometimes seen on the shoulder. Length, $\frac{3}{4}$ inch.

Habitat.—Tennessee.

Sub-Genus STREPHOBASIS, Lea

This small group includes a few conical shells in which the short canal is twisted under the shell.

A. curta, Hald., is greenish-brown and stoutly cylindrical, with a narrow aperture closed with a dark brown operculum. The canal is drawn under by the twisting of the columella. Length, 1 inch.

Habitat.—Tennessee.

Sub-Genus PLEUROCERA, Raf.

Shell elongated, conical, regular; aperture with short canal; columella without callus. Tryon describes eighty-two species.

The **Ponderous Pleurocera** (*A. ponderosa*, Say) is a heavy cone of flat coils, the last one keeled. The short lip canal turns to the left. The surface is olive, the lining white. Length, 2 inches.

Habitat.—Tennessee.

A. undulata, Say, has a handsome elevated spire of broad flat coils that cover a row of knobs, and so produce wavy folds below the deep suture. The white lip projects. Length, $1\frac{1}{2}$ inches.

Habitat.—Ohio River.

A. canaliculata, Say, is distinguished by its distinct groove on the body whorl. Variable in form and size and ranging in colour from pale green or yellow to black, yet it is distinct. It is very common at the falls. Length, 1 inch.

Habitat.—Ohio River.

Genus GONIOBASIS, Lea

Shell heavy, ovate or elongated; aperture angled in front, but without canal or notch. A large genus of one hundred and fifty species, one-half of the entire family, distributed east of



MARSH AND APPLE SNAILS

- | | |
|---|---|
| 1 Marsh Snail, <i>Vivipara Bengalensis</i> . | 5 Marsh Snail, <i>Vivipara intertexta</i> . |
| 2 Marsh Snail, <i>Vivipara contectoides</i> . | 6 Jug Apple Snail, <i>Ampullaria ampullacea</i> . |
| 3 Prickly Black Snail, <i>Melania asperata</i> . | 7 Purple Apple Snail, <i>Ampullaria purpurea</i> . |
| 4 Flattened Apple Snail, <i>Ampullaria depressa</i> . | 8 Ram's-horn Apple Snail, <i>Ampullaria cornu-arietis</i> . |
| 9 Green Apple Snail, <i>Campeloma decisa</i> . | |



ROUND-MOUTHED SNAILS

- 1 *Cyclostoma pulchra*.
- 2 *Cyclotus giganteus*.
- 3, 6, 7 *Pterocyclos anguliferus*.

- 4 *Chondropoma magnifica*.
- 5 *Cyclostoma sulcata*.
- 8 *Otopoma naticoides*.
- 9 *Cyclostoma Cuvierianum*.

- 10 *Cyclophorus volvulus*.
- 11 *Cyclophorus Siamensis*.
- 12 *Adamsiella mirabilis*.

the Mississippi, but well represented (as is no other genus) on the Pacific slope of the Rocky Mountains.

The collector must search for these snails in the clear water of creeks that flow down mountain slopes. The green algæ are their accustomed food.

The **Virginian Goniobasis** (*G. Virginica*, Gmel.) is slender and long, with about six whorls, rounded a little, and banded with red near the middle and base of each. Some forms are finely ridged throughout, with ten or twenty lines on the body whorl. The tip is always worn off. The colour is dark brown or olivaceous. Length, 1 to 1 $\frac{3}{4}$ inches.

Habitat.— Delaware and Schuylkill rivers.

The **Plaited River Shell** (*G. plicifera*, Lea) has keen-edged folds crossing the whorls to the very apex of its horn-like spire. But for its dark complexion this river shell might be mistaken for one of the ladder shells, though the latter are marine mollusks and decidedly pale. Length, 1 inch.

Habitat.— Oregon.

The **Sharp-Lined River Shell** (*G. acutifilosa*, Strns.) bears a double row of sharp tubercles winding up its tall spire, and below these, on the body whorl are four or five plain, sharp keels that very prettily crimp the thin outer lip. The tip is usually missing, else the shell would be over an inch long.

Habitat.— Eagle Lake, Cal.

G. rubiginosa, Lea, is rusty, with spiral keels on all but the smooth body whorl.

Habitat.— Oregon.

G. nigrina, Lea, is black, has smooth, rounded whorls, and is slender. Length, about $\frac{3}{4}$ inch.

Habitat.— Tributaries of the Sacramento River.

G. bulbosa, Gld., smooth, and swollen, lives in streams that feed the Columbia River.

CHAPTER XL: THE SPIRE SHELLS AND FLOOD SHELLS

FAMILY RISSOIDÆ

SHELL small, top-shaped or elongated; mouth rounded, scarcely channeled. A family of small marine mollusks living on seaweeds, to which they are suspended by a mucous thread.

Genus RISSOA, Freim.

Characters of the family. Two hundred species, abundant chiefly in shallow seas.

R. minuta, Totten, is a smooth, blunt-pointed shell, with rounded, finely striated whorls. It is yellowish brown and clings by a thread to the leaves of seaweeds. Length, $\frac{1}{4}$ inch.

Habitat.—New England to New Jersey.

R. acutilirata Cpr., $\frac{1}{10}$ to $\frac{1}{8}$ inch long, is worthy of examination under a lens. Its brownish yellow surface is marked by sharp intersecting ribs. It is found on seaweed.

Habitat.—San Diego, Cal.

Genus RISSOINA, D'orb.

Resembles Rissoa except that the aperture and operculum are ear-shaped, and the latter has a blade-like projection on its inner surface. Warm coasts.

R. fenestrata, Schwartz, is a white shell, blunt at apex, drawn in at base, its rounded whorls strongly ribbed longitudinally and spirally, making the surface regularly "windowed," as the specific name implies. Length, $\frac{1}{8}$ to $\frac{1}{3}$ inch.

Genus BARLEEIA, Clark

Shell smooth, spiral elongated; aperture round; operculum not spiral; with internal projection.

B. haliotiphila, Cpr., may be found in colonies comfortably quartered among the coralline tufts that flourish on the shell of

Halotis, the Abalone, on the California coast. It is a simple conical shell $\frac{1}{8}$ inch long. Whether the Abalone is conscious of the burden it carries, I cannot say. Probably it counts these passengers as a part of its scheme of protective coloration. If so, then the little halotis-lover pays for his lodging, and the migrations of the host help to keep the stationary guest mollusks supplied with food.

Genus AMNICOLA, Gld. and Hald.

Shell small, short, ovate or globose, thin, smooth; apex not acute; aperture broadly ovate, not oblique; lip thin, sharp; not projecting below; operculum horny, spiral. Foot short, broad, rounded behind; tentacles blunt; snout short; egg cases pod-like, short, one egg in each. A fresh-water snail of North America. Species few.

A. limosa, Say, the type, is dark horn-coloured, often encrusted with black, as it is found in muddy stream borders; the body is white, marked with brown above. Say found them numerous on the banks of Schuylkill and Delaware rivers, between high and low tides. Length, $\frac{3}{10}$ inch.

Habitat.—Hudson Bay region to Wisconsin and Virginia.

Genus FLUMINICOLA, Stimps.

Shell obliquely ovate, thick, smooth, spire blunt; inner lip flat and callous, outer lip spreading, especially below; operculum horny. Egg cases lens-shaped, containing many eggs. Found in fresh water in Oregon and California.

Nuttall's Flood Shell (*F. Nuttalliana*, Lea) may be distinguished from neighbouring genera by its solid shell and sub-spiral operculum. It has been given five other generic names. The rivers of the two western states mentioned furnish plenty of specimens. Length, $\frac{2}{3}$ inch.

A green species, **F. virens**, Lea, somewhat slender and oblique, but very thick, and a very stout, almost spherical one. **F. fusca**, Hald., reddish, with white lip, and the size of a pea, inhabits Oregon streams.

Genus POMATIOPSIS, Tryon.

Shell small, thin, elongated, of few very much rounded whorls; aperture round, lip continuous, extended or reflected;

The Spire Shells and Flood Shells

operculum horny. Foot very broad; snout extensible; gill present, but the mollusk breathes air.

P. lapidaria, Say, is a little pebble-like snail, scarce large enough to earn a name. It is found in moist situations, under stones, on river banks, and is able to crawl along the surface of the water with its shell hanging downward. But it is uncomfortable in water. On land it progresses by fastening the tip of the snout, and drawing the body up to it, thus taking "steps." Length, $\frac{1}{8}$ inch.

Habitat.—Michigan and Missouri to Georgia and New York.

P. Californica, Pils., has a turreted-conic, thin, brown shell with a pit underneath the rounded whorls. Length, $\frac{1}{8}$ inch.

Habitat.—Small streams about San Francisco Bay.

CHAPTER XLI: THE SENTINEL SHELLS

FAMILY ASSIMINIIDÆ

SHELL small, globose-conical, with sharp lip; operculum of few coils, horny, nucleus on the side; gills replaced by a pulmonary sac; tentacles wanting; eyes on very long stalks, and the active mollusks appear to be keeping a sharp lookout for danger. Terrestrial or amphibious mollusks. Found in Europe, Asia and America.

Genus ASSIMINEA, Leach.

A. Francesiæ, of India, one of the few species of this sole genus in the family, remains on land for days, "looping" along at great speed, exactly like a "measuring worm," using the snout and small foot alternately. The tentacles and the eyestalks that branch from them are of equal length.

Two Californian species have been reported.

CHAPTER XLII: THE VALVE SHELLS

FAMILY VALVATIDÆ

SHELL depressed, often almost discoidal, umbilicated; operculum round; epidermis green. Animal with long snout and tentacles; foot cleft in front; branchial plume long, branched, thrust partially out when the mollusk is walking. Teeth of radula in seven series, broad, hooked. Fresh water or terrestrial mollusks.

Genus VALVATA, Müll.

Characters of the family. Small, thin, flat-coiled shells, found in slow-running brooks and ditches, or ponds, in Europe and North America. The eggs are laid in a single globular capsule. The capsules are fastened to pebbles or stems of plants.

The **Three-keeled Valve Shell** (*V. tricarinata*, Say) exhibits three coils, each of which bears a keeled shoulder. The mouth is round, expanding like a bell; the operculum is spiral with a central nucleus. When progressing, the gill plume is lifted above the head. Diameter, $\frac{1}{8}$ inch.

Habitat.—Delaware River.

V. sincera, Say, similar in most particulars to the preceding, has rounded whorls. The pit is larger.

Habitat.—Northwest Territory.

The **Green Valve Shell** (*V. virens*, Tryon), a minute, swollen top shell, bright green, is $\frac{1}{8}$ inch in diameter.

Habitat.—Clear Lake, Cal.

CHAPTER XLIII: THE POND SNAILS. RIVER SNAILS

FAMILY VIVIPARIDÆ (PALUDINIDÆ)

SHELL turban-shaped; aperture simple; lip continuous; epidermis olivaceous; operculum annular; foot large; snout short, stout; right tentacle enlarged in male; eyes on base of tentacles; teeth broad, serrated. Animal ovoviviparous.

Genus VIVIPARA, Lam.

Shell thin; spire produced; surface smooth; body dark; head large; foot thick, not extending beyond the moderate snout; neck lappets forming troughs to admit and discharge water from the gill chamber.

V. intertexta, Say, is globular, with three or four yellowish green or brownish whorls; the elevated apex is worn at the tip; the lines on the surface are but skin deep. Lip continuous and white. Maximum length and breadth, 1 inch.

Habitat.— Marshes of Louisiana.

Mr. Binney received specimens from Iowa and South Carolina.

V. multicarinata, Hald., bears distinct raised revolving and cross lines, on the green conical shell. The mouth is round and large. Length, $1\frac{1}{4}$ inches. Southern states.

V. contectoides, Binney, has five greenish rounded coils forming a tall spire, and ending in a round mouth. Cross streaks intersect the four revolving bands of brown which show through the thin shell substance. A variable and handsome species, allied to the European, *V. contecta*. Length, 1 inch.

Habitat.— Michigan and Arkansas to Florida.

Mr. Maxwell Smith has recently found *Vivipara* in locks of the Erie Canal at Rochester, N. Y.

Genus TULOTOMA, Hald.

The **Magnificent Tulotoma** (*T. magnifica*, Conr.) is a solid conical shell with two spiral rows of tubercles on the body whorl,

The Pond Snails. River Snails

and a single row winding to the truncated apex. This shell is the handsomest in the family. It is found on masses of crumbling limestone fallen from the river banks. The greenish epidermis contrasts pleasingly with the rich purple or salmon colour of the smooth lining. Height, 1 to 2 inches.

Habitat.—Alabama River at Claiborne.

Genus MELANTHO, Bowditch

Shell ovate; spire elevated; whorls rounded, smooth; peristome continuous, simple; epidermis olive; foot large, thin, protruding much beyond the small snout; flesh pale, red-dotted; teeth small.

The **Heavy Melantho** (*M. ponderosa*, Say), typifies the genus. The inner lip is applied as a thickening fold to the columella. Dark streaks are painted on the greenish exterior. The lining is white; so is the surface under the horny epidermis. The animal has a curious habit of flattening the foot and curling it outward into a thin scroll, square in front. The neck lappets are not grooved as water ducts. Length, $1\frac{1}{2}$ to 2 inches.

Habitat.—Lake Superior to Alabama.

Genus LIOPLAX, Troschel

Shell thin, ovate; spire elongated; foot large, square in front, rounded behind, projecting beyond small head. A few species in the United States. Variable.

L. subcarinata, Say, has three rounded whorls, smooth or showing a few faint elevated revolving lines. The apex is often worn; the aperture oval. The foot is purplish in front, the head pale orange, the eyes black. Length, $\frac{1}{2}$ inch.

Habitat.—Delaware River.

CHAPTER XLIV: THE APPLE SNAILS. FLASK SNAILS

FAMILY AMPULLARIIDÆ

SHELL globular, with large body whorl; spire short, depressed, sometimes making the coil flat; aperture somewhat expanded; operculum concentric. Animal with long siphon, left gill much smaller than right; muzzle ending in two long feelers; tentacles very long.

An amphibious family of tropical distribution in both hemispheres, corresponding to the Paludinidæ in ponds and streams of temperate regions. The gills lie in a large, partially closed breathing cavity, which adapts the mollusks to life out of water. In dry seasons they bury themselves in mud; indeed, they survive removal from water for months, breathing air, but probably keeping the air chamber moist. The typical genus has a green, shiny epidermis.

The large eggs are laid in limy capsules, which adhere in round masses to the stems of water plants. When fresh they are beautifully coloured, crimson, pink or bluish green.

Genus AMPULLARIA, Lam.

Lip continuous, reflected, thickened inside, operculum horny, with shelly coat outside. A large genus of striking coloration and size.

The **Giant Flask Shell** (*A. gigas*, Spix), as large as a man's clenched fist, is a formidable snail. The great aperture almost conceals the rest of the shell with its continuous flaring rim, as one looks down into its blue-banded depths. The spire is deeply channeled and sunken well into the inflated body whorl. The horny olive surface bears many narrow bands of green. The pit is deep; the lip yellowish and spotted. Diameter, 4 to 6 inches.

Habitat.—Brazil.

The Apple Snails. Flask Snails

The **Noble Flask Shell** (*A. nobilis*, Rve.), has a more elevated spire, which gives the shell a squat, pear-shaped outline. The horny olive surface is obscurely banded with brown. The great aperture reveals a pale, unbanded interior, painted on the recurved lip with bright, dark red. Diameter, 4 to 5 inches.

Habitat.—Brazil.

In several other species the protruding thick lip is strikingly banded and coloured.

The **Paper Apple Snail** (*A. papyracea*, Spix) is thin-shelled and black as ink. Diameter, 3 to 4 inches.

Habitat.—Rivers of Western Brazil.

The **Island Apple Snail** (*A. insularum*, d'Orb.) has its greenish globose body whorl finely striated, and often creased as if hammered. The gaping mouth glows orange red. This species inhabits lakes and brooks, among the stems of water plants. A specimen survived a year's sojourn in a cabinet, reviving promptly when put into water.

Habitat.—Isles of Parana in the La Plata River.

Genus POMUS, Humphrey

Lip thin at margin; operculum horny. Inhabits South America, West Indies and Florida. "Idol Shell" is an Indian name in South America, where the shells are venerated.

The **Flattened Apple Snail** (*P. depressa*, Say) is swollen almost to globular form, the spire flattened, the olive-green surface banded with narrow lines of darker green and brown, unequally spaced. The aperture is oval and very large, with a thin lip, scarcely flaring. The pit is nearly closed. Length and breadth, $1\frac{1}{2}$ inches.

Habitat.—Tributaries of St. John's River, Eastern Florida.

CHAPTER XLV: THE LOOPING SNAILS

FAMILY TRUNCATELLIDÆ

SHELL very small, elongated, truncated; aperture round; lip continuous. Animal with small foot and head; snout large, as long as the body. Amphibious mollusks, inhabiting salt marshes and stream borders, where they walk by looping along like measuring worms, using the foot and snout.

Genus TRUNCATELLA, Risso

A tropical genus of world-wide range. Several species of these minute shells venture north into the States from Mexico and the West Indies. All are finely ridged across the whorls.

T. bilabiata, Pfr., has a two-ridged lip. The surface is brownish, solid, elegantly carved. The apex is gone. Length, $\frac{1}{8}$ inch.

Habitat.—Cuba, Florida.

T. pulchella, Pfr., is more tapering, amber and shining, about the same size, with a single thick rim.

Habitat.—West Indies, Florida.

The **California Looping Snail** (*T. Californica*, Pfr.) has a minute horny shell, whose smooth whorls, separated by a deep suture, form a slim cylinder a quarter of an inch long. Only practised eyes can find this little creature, looping along on seaweed or stones, or in salt meadows on grass stems.

CHAPTER XLVI: THE ROUND-MOUTHED SNAILS

FAMILY CYCLOSTOMIDÆ

SHELL spiral, often depressed, not much elongated; mouth round, lip simple; operculum spiral, circular; foot long; lingual teeth hooked, recurved, in seven rows; mouth proboscis-like, without jaws; air sac on back of neck, with open mouth; sexes distinct; reproduction oviparous.

A large family of terrestrial, air-breathing snails, resembling the Littorinidæ in structure. Chiefly tropical, in the eastern hemisphere.

Genus CYCLOSTOMA, Lam.

Shell cone-shaped to globose, thin; umbilicus wide; operculum spiral, calcareous, foot divided in middle line, sides move alternately in walking; snout is used too, so locomotion is somewhat like the looping snail's. A large genus, with range centred in Madagascar.

Cuvier's Cyclostoma (*C. Cuvieranum*, Petit.), the giant of the genus, much depressed and thin, is strikingly angled with two sharp keels, separated by a flat plane, and the whole surface is finely striated. The colour is dull, a pale chocolate hue, darker on the keels. The lip flares, and is thickened with an inner rim of white enamel. The pit is wide and deep, all but piercing the apex. These mollusks are representative of a group of species of large size, and handsome form and sculpture. Diameter, $2\frac{1}{2}$ inches.

Habitat.—Madagascar.

The **Natica-like Cyclostoma** (*C. Naticoides*, Pfr.) is solid, polished, flesh-pink, with rounded whorls increasing to a swollen body whorl, and a thickened, scarcely flaring lip. An ear-like lobe of callus closes the pit. The shell lining is orange-hued.

Habitat.—Socotra, north of Madagascar.

The **Beautiful Cyclostoma** (*C. pulchra*, Gray) has three exquisitely fluted coils that flare into a wide ruffle about the circular aperture. The apex is elevated, the pit deep and wide. Colour, pale brown, obscurely spotted. This is one of the most beautiful West Indian species. Diameter, 1 inch or more.

Habitat.—Jamaica.

Genus CHONDROPOMA, Pfr.

Shell oblong, turreted, of few rounded whorls, aperture rounded; lip flaring; operculum spiral, flat; nucleus eccentric.

Our American species, *C. dentata*, Say, is very plain, beside the more highly ornamented Cuban species. It is finely cancellated, yellow with brownish streaks both ways, and the slender spire is usually broken off. The mollusk has a curious habit of spinning a thread by which it hangs suspended from a leaf or other convenient object, with its operculum closed tight. It is very quick of motion, gliding along on its foot, and advancing the shell by a series of jerks. Length, $\frac{1}{2}$ inch.

Habitat.—Southern Florida.

C. Shuttleworthi, Pfr., is variable in markings, but always brown on a pale ground. The rounded whorls are covered with close spiral striæ, and the lip is bordered with a wavy frill, rayed with brown. Length, 1 inch.

Habitat.—Cuba.

Genus CYCLOTUS, Guilding

Shell depressed, turbinated, elegantly convoluted, broadly pitted, and enveloped in an epidermis of brown, usually banded; mouth small, circular; lip continuous, simple, sometimes flaring. Tropical. The finest species are in the New World.

The **Giant Cyclotus** (*C. giganteus*, Gray) has a flattened spire of rounded whorls, the rich chestnut surface banded with a darker brown and stained with olive. The flaring lip and circular, spiral operculum are white, tinged with brown. This handsome snail frequents the woods of Panama. Diameter, 2 inches.

CHAPTER XLVII: THE HELICINAS

FAMILY HELICIDÆ

SHELL top-shaped, globose or depressed; aperture semi-lunar; columella callous; lip thick; operculum not spiral, made of overlapping plates. Head bearing a stout, blunt proboscis; foot long; radula long, narrow; jaw absent. A tropical family of several genera, living in damp situations in forests.

Genus *HELICINA*, Lam.

Characters of the family. Three hundred and fifty species. Distribution, world-wide.

H. orbiculata, Say, is a tiny globular shell, brownish yellow, sometimes spotted, with a thick white lip. The operculum folds back upon the columella as if hinged to it when the animal is gliding along. Diameter, $\frac{1}{8}$ inch.

Habitat.—Tennessee to Texas and Florida.

H. agglutinans, Sby., has a depressed shell and a single keel, decorated with frond-like processes. The inner lip is much thickened. Diameter, $\frac{3}{4}$ inch.

Habitat.—Philippines.

H. Briarea, Poey., has a flattened dome almost covered with brown, but white below and at the sutures. The wide aperture is white and polished. Diameter, 1 inch.

Habitat.—Cuba.

CHAPTER XLVIII: THE SEA SNAILS. BLEEDING TOOTH

FAMILY NERITIDÆ

SHELL solid, imperforate, top-shaped to patelliform; spire flattened; interior partitions absorbed; body whorl very large; muscle scar horse-shoe-shaped, seen in aperture; columellar region broad; lip simple or toothed; operculum calcareous, spiral or not, with prominent teeth on inner face, one of which locks behind the columellar lip. Snout short; radula long, well developed; tentacles long; eyes on stalks; gill single, on left side, triangular, free; mantle edges without cirrhi. A large family of littoral forms, most of which belong to tropical and subtropical oceans. They are greedy vegetable feeders, living on seaweeds. It is said that they are nocturnal in habits, ranging and feeding only at night. They are found near low water on rocks.

Genus NERITA, Linn.

Shell thick, smooth or spirally ridged and grooved, porcelainous, usually with horny epidermis; outer lip thick, columellar lip flattened, straight, toothed at margin. Animal with festooned mantle border. Feeds on algæ by night. A gregarious, littoral genus, in warm oceans, including two hundred living and sixty fossil species.

The **Bleeding Tooth** (*N. peleronia*, Linn.) is found on the beaches of Southern Florida. It is well known among the coast dwellers. The broad columella bears two teeth, one or both of which are stained with a yellowish, bloody patch. The operculum is shelly and ear-shaped, and shuts more strongly because of a hinge formed by its hook locking behind one of the columellar teeth. The shell thickens greatly just back of the lip. Parallel ridges extend from spire to lip, crossed by fine striæ.

The "bleeding tooth" is about $1\frac{1}{2}$ inches long; zigzag bands of purple, red and black on a white ground make it a handsome shell. There is great variation of pattern and colouring within the species. The mollusk is a rapacious feeder upon seaweeds. It is notable for the length of its rasping tongue.

N. versicolor, Gmel., is gay with streaks and squares of red and black, alternating with the whitish ground colour. Numerous strong rounded ribs follow the spiral and are crossed by zigzag markings. The species is smaller than the bleeding tooth and may be recognised by the four teeth on the convex lip of the columella. It is a West Indian species that ventures into Southern Florida.

The **Tessellated Nerite** (*N. tessellata*, Gmel.) has a checkered dark and light surface like a chess board, or in less regular arrangement, resembles the pattern shown in a snake's skin. Inside the aperture the outer lip is toothed, and small teeth are borne on the columellar lip. This solid, humped species is about an inch long. It occurs on the southeast coast of Florida, frequenting coral reefs and rocky beaches.

The three species described above are the only North American representatives of the genus.

Genus **NERITINA**, Lam. (**NERITELLA**, Humph.)

Shells thin, globose, with short spire, usually smooth; columellar lip broad, with fine marginal teeth, or smooth; outer lip sharp, not toothed within.

This genus includes about two hundred species. They live in rivers, except a few marine and brackish water species, and some which are amphibious, clinging to roots of trees on river margins. A few are terrestrial but live among the tree foliage overhanging the water. Most of them are tropical or sub-tropical in distribution.

The shells look like dainty, polished replicas of the Floridian "bleeding tooth." The animal within differs in no important particular from those of the more sturdy genus, *Nerita*. As with other tropical shells, there is much beauty of colour and pattern exhibited in this large group. Many forms are ornamented with spines.

The **European Nerite** (*N. fluviatilis*, Linn.) inhabits the

gravelly bottoms of clear rivers; it extends over a very large area, and has many varieties, some of which live in brackish water, and a few in salt water. The shell is transverse, the last whorl much swollen, white or decorated in a great variety of colours and designs. The largest are about $\frac{1}{2}$ inch in diameter.

This mollusk lays its globular egg capsules on the shell of another individual. Each capsule contains fifty or sixty eggs. But only one of these develops. The remaining eggs serve to nourish the one growing offspring the capsule contains. We are strongly reminded of the "Yarn of the Nancy Bell." It would seem an unnecessary expense to feed a favoured individual on his own brothers and sisters because he happened to be the first to hatch, and so had them at a disadvantage.

N. reclivata, Say, is an olive or light brown shell, marked with fine zigzag lines of black, and about $\frac{3}{8}$ inch in diameter. It is found in inland rivers of Florida. **N. viridis**, Linn., is a small bright green marine species. It is rarely found on Florida and Texas coasts.

N. Virginea, Linn., West Indies to Brazil, has a beautifully polished shell with markings of white and Quaker drab and gray which are strikingly like the plumage of a Guinea fowl.

Some Neritinas resemble the slipper shells in form. Some add to the boat shape two wide lateral wings, doubling the width of the boat's seat. The animal is often as highly coloured as its shell, with broad foot, an enfolding mantle lining the shell's mouth, and long, slender tentacles.

Genus NAVICELLA, Lam.

Shell oblong, limpet-like, apex on posterior margin, columellar shelf broad, not toothed, operculum shelly; nucleus lateral.

This genus of about fifty species is briefly mentioned here because its shells in a collection are likely to be referred to the limpets or the slipper shells, both of which they resemble. They come from the East Indies and Polynesia, where they live on floating sticks and roots of palm trees so as to be near the water.

N. Janelli, Recl., looks like half of a bivalve shell, roundish like a scallop, the beak at one end, Narrow longitudinal ridges are crossed by occasional lines of growth.

CHAPTER XLIX: THE LIOTIAS

FAMILY LIOTIIDÆ

SHELL small, solid, turban-shaped, body whorl large, with longitudinal and spiral ribs and thickened lip; aperture round; operculum many-whorled, horny, with limy layer.

Genus LIOTIA, Gray

Characters of the family. Chiefly tropical species, in Pacific and Indian Oceans. A few West Indian species.

Two small species inhabit shores of Santa Catalina Island, California. *L. fenestrata*, Cpr., is a much depressed, oblique shell, regularly sculptured by cross ridges and deep fissures. The lip is thick; the umbilicus wide and deep. Diameter, $\frac{1}{8}$ to $\frac{1}{3}$ inch. *L. acuticosta*, Cpr., has no cross ridges cutting its whorls; their angles are set with faint nodules. It is $\frac{1}{8}$ inch in diameter, and less flattened than the previous species. There is no umbilicus. Both species are yellowish white.

L. Bairdii, Dall, a minute, few-whorled turban, $\frac{1}{4}$ inch in both diameters, is one of several southern species.

Habitat.—Cape Hatteras southward.

CHAPTER L: THE PHEASANT SHELLS

FAMILY PHASIANELLIDÆ

Genus PHASIANELLA, Lam.

SHELL spiral, with tapering apex and inflated body whorl, polished, ornamented with bright colours in elaborate pattern, not pearly within; operculum thick, convex and white without; head with long tentacles and notched veil between them; foot long, narrow, grooved in the centre.

Nobody will be surprised to read that the home of this genus is in the Philippines and Australia. No pheasant's plumage exhibits more variety of colours, more intricacy of pattern than the polished surfaces of these shells. Even the northern species, though very small, exhibit wonderful beauty of decoration. The dark rich colours almost cover the pale ground colour, but leave enough showing for effective contrast.

These mollusks are distinguished by a peculiarity of gait shared with certain top shells. They move one side of the foot at a time in gliding, one side remaining stationary with each "step." To most people "a snail's pace" is a metaphor, meaning a *rate* rather than a *method* of progress. The pheasant's gait is a pace, quite within the technical definition of the most exacting turfman. Without seeing it, we may imagine it a peculiar system of tacking from left to right, alternately, for the creature has but one foot, and the contractions must wag the head, if not the whole body, from side to side.

The **Australian Pheasant Shell** (*P. Australis*, Gmel.) is the largest of its family, 2 to 4 inches long and 1 to 2 inches in greatest diameter. Great variety of colouring exists within the species. Under the rich, dark bands and within the oval aperture shows the white china-like under-stratum.

European and North American pheasants are seen with greatest satisfaction under a microscope. *P. pulla*, Linn., less than $\frac{1}{2}$ inch long, occurs from England to the Azores and on Mediter-

• The Pheasant Shells

anean and Adriatic beaches. Some have rosy patterns, others brown and yellow, others purplish and drab. *P. tenuis*, Mich. is a trifle longer, its whorls rounded, the pattern blending red and yellow on a pale ground. Mediterranean and Adriatic shores.

Florida and the West Indies and California have representatives of this genus, all very small shells, but graceful and prettily marked. *P. affinis*, C. B. Ads., $\frac{1}{3}$ inch in height, is regularly dotted with pink, with broad longitudinal dull streaks clouding the pale ground colour. *P. tessellata*, smaller but much stouter in shape, is checkered with red lines crossing at right angles, and white figures, elongated or crescent shaped, are regularly scattered on its whorls. *P. umbilicata*, d'Orb., dotted and blotched with red on a white ground, is provided with a deep umbilicus. Cuba and Florida.

On the California coast *P. compta*, Gld., a very small pheasant shell, with elongated spire, has longitudinal banding of purple or gray crossed by fine spiral lines of rose or drab. This species occurs in several distinct varieties.

Sandy beaches yield plenty of the dead shells, whose beauty can only be enjoyed by using a lens. The living creatures may be collected from the blades of sea grass.

CHAPTER LI: THE TURBAN SHELLS AND STAR SHELLS

FAMILY TURBINIDÆ

SHELL spiral, turban-shaped, solid, with simple circular or oval aperture; operculum calcareous, heavy, convex outside, with thin, flat, spiral, horny layer on inner face, nucleus not central. Body with oval foot, square in front, bearing cirrhi along sides; head bears a veil between the two long tentacles, with two eyes on short stalks at their outer bases; radula well developed; food vegetable; habitat, shores of warm oceans. A large family of several genera, chiefly distinguished from the Trochidæ by the calcareous nature of the thick operculum, and by its few coils.

Genus **TURBO**, Linn.

Shell turban-shaped, usually large, heavy; whorls rounded; aperture nearly round, more or less drawn out at base; operculum circular, flat or concave inside.

The **Green Snail** (*T. marmoratus*, Linn.) of the curio-dealer and collector, is the giant of the family of turban shells. It has the characteristic turban shape with the spire somewhat depressed, and the whorls few, square-shouldered and knobbed, the body whorl much larger than the others. The largest shells are eight inches in height and diameter. The columellar region is excavated considerably; there is no umbilicus.

In its natural state the green snail shell has a horny outer layer of rich green mottled with brown and white. It has opaline tints which exhibit much more beauty when the surface is rubbed to free it of the horny layer. Green prevails in the rainbow tints when the outer shell layer is entirely removed, leaving the surface uniformly pearly, inside and out.

As an ornament for shell cabinets and mantelpieces these "green snails" are familiar to many. In Scandinavia the monarchs have from the earliest times had these shells mounted in silver and studded with gems for royal drinking cups. They

The Turban Shells and Star Shells

are not actually used as such nowadays, but kept in cabinets in deference to old usage. The Japanese cut up the soft parts of this species and use it for making chop suey. The thick, pearly substance of the shells is cut into buttons and ornaments.

Habitat.—Indian Ocean, Philippines, Japan Sea.

The genus *Turbo* is divided into several sub-genera, based upon differences of the radula and operculum.

Sub-genus **SARMATICUS**, Gray

Shell depressed, much broadened at base, with oblique long aperture and broad columella. Operculum beset outside with club-shaped processes, inside flat.

The **Turk's Cap** (*T. Sarmaticus*, Linn.) comes from the Cape region of South Africa in such quantities that shell dealers all handle it, and collectors can always get specimens. It is a handsome shell, showing beautiful green lights in its pearly mouth. The outside of the shell is normally brown, more or less ruddy toward the apex, and showing streakings of white and orange-red toward the mouth. Underlying the coloured coat is a layer of black, brittle as lacquer, next to the pearl. A tongue of black reaches well into the aperture, encircling the columella. The thin rim of the aperture is edged with this same black, the pearl not reaching the edge. A very little grinding and rubbing removes the outer layers, and leaves the shell pearly throughout. Its altitude is 2 to 4 inches; diameter 3 to 5 inches. A strange coral-like or mushroom-like growth covers the outside of the operculum.

The shells are made into fancy articles such as purses, stamp cases, scent bottles, pipe bowls and ring trays. The choicest specimens are made into brooches, cuff buttons and earrings.

T. petholatus, Linn., is like the pheasant shells in being smooth and brightly polished, and decorated with bright colours, combined with white, in great variety and intricacy of pattern. They are 2 to 3 inches in altitude and much more dilated at base than the pheasants. The operculum is convex on the exterior, and polished, with a bright green spot in the middle.

Habitat.—Red Sea, Philippines and Indian Ocean.

Sub-genus **CALLOPOMA**, Gray

Shell turban-shaped, dark-coloured, with round aperture, and long, deep columellar groove; outside of operculum spiral with deep central pit, the outer coils with deep-cut grooves or teeth.

T. fluctuosa, Wood, of the west coast, is about two inches high and perhaps a trifle wider. Outside of the pearly shell is a thin coloured layer, brown and white in a bright tessellated pattern, moulded over the sculpturing which consists of fine spiral and radiating ridges and rows of faint nodules on the shoulders of the whorls. The operculum is deeply cut, as described above.

Habitat.—California.

Genus POMAULAX, Gray

Shell large, conic, solid, imperforate; periphery keeled; base flat; operculum obovate.

The **Wavy Pomaulax** (*P. undosum*, Wood) is one of the large shells of the California coast. An altitude of five inches and diameter of six inches is not unusual, though the average is lower. A horny epidermis made of fine overlapping laminæ covers the shell to its aperture. It is moulded over a series of nodules that form a ridge like a twisted cord at the outer edge of each whorl. The face of the whorl is further decorated with regular rows of fine knobs and folds. The shell has a thick pearly lining. The shelly layer is pale tinged with brown under the epidermis. The columella has a pearly crescentic groove. Cleaned with acids these pearly top shells are sold at good prices to tourists.

P. inequale, Martyn, is similar to the last species but smaller, with close, uniform oblique folds crossing all its whorls, and the "twisted cord" at the periphery of each less prominent. The surface is brick red when alive. The base is deeply cut between close spiral ridges. Aperture smooth, lined with white; columellar edge curved, pearly, ending in a tooth below. This species is 2 inches high and $2\frac{1}{2}$ inches in diameter.

Habitat.—Vancouver Island southward.

Genus ASTRALIUM, Link

Shell conical, flattened above and below; young individuals depressed, keeled and spiny at periphery; operculum oval, spiral.

The **Star Shell** (*A. longispina*, Lam.) of the West Indies, has a flattened cone, and triangular, hollow spines all around its thin outer edge, and following the coils toward the apex. The flat base is sculptured by thin laminæ, radiating from the deep umbilicus. The whorls above have beside the large projecting sutural spines a thick sprinkling of recurved hollow tubercles.

The Turban Shells and Star Shells

The colour is dirty white, texture calcareous, aperture pearly-lined; the operculum is smooth, white, rounded, with a depression in one side. Height, 1 inch; diameter, 2 inches.

Var. *spinulosum*, Lam., is found on the Florida coasts. It has a higher cone than the typical *longispina*, has no umbilicus, and its spines, tubercles and the basal laminæ are much reduced in size. The average specimen is $1\frac{1}{2}$ inches in altitude, and 2 inches across the base, but the ratio of height to diameter is variable. The specimens examined are decorated with brownish streaks and speckles.

A. latispina, Phil., is a high cone, armed with triangular spines of small size along the outer margins of the whorls, and short, oblique ridges between. The dull white surface is streaked with brown and yellow. The base has spiral ridges crossed by fine striæ. This species is $1\frac{1}{2}$ inches high and 2 inches in diameter.

Habitat.—Gulf of Mexico to Rio de Janeiro.

Sub-genus LITHOPOMA

A section of *Astraliu*m containing very solid, turban-shaped shells, with the whorls radiately folded or plaited, and the periphery rounded or keeled.

The **Stone Apple** (*A. tuber*, Linn.) is a heavy turban-shaped shell, distinguished by the regular diagonal plaiting of ridges and valleys that alternately follow down its whorls. The colour follows the plan of sculpture; the valleys are dark, the elevations light. Brown and pale green overlies the dirty white ground colour. The base is paler and has finer markings. A little rubbing exposes the pearly interior substance.

A character that keeps this species in the genus *Astraliu*m is the presence of spinous processes around the periphery of young shells; these ultimately wear off. Elsewhere, in the genus *Turbo*, such processes become more prominent as growth proceeds.

This West Indian shell occurs on East Florida beaches. It attains an altitude of two inches and an equal diameter.

*A. Americanu*m, Gmel., is of the same stony group, but with a still higher cone. The diameter of 1 to $1\frac{1}{2}$ inches is generally a trifle less than the altitude. The whorls are keeled on the outer edges; oblique folds cross them, and end in a row of nodules on the keels.

Habitat.—Florida Keys and throughout the West Indies.



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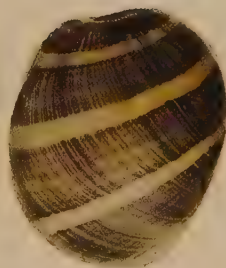
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UNIVALVE SHELLS OF TROPICAL SEAS

26 Cowry or Venus Shell, *Cypraea Mauritiana*, Linn.27 Imperial Turban Shell, *Turbo imperialis*, Linn.28 Fringed Dolphin Shell, *Delphinula laciniata*, Lam.29 Polished Sea Snail, *Nerita polita*, Linn.30 Magpie Top Shell, *Livona pica*, Linn.31 Shell-bearing Slug, *Hydatina physis*, Linn.32 Pheasant Shell, *Phasianella australis*, Gmel.33 Pointed Top Shell, *Trochus acutangulus*, Chemn.34 Tiger Top Shell, *Calliostoma tigris*, Mart.

CHAPTER LII: THE TOP SHELLS AND DOLPHIN SHELLS

FAMILY TROCHIDÆ

SHELL top-shaped or conical, spiral, pearly within; operculum thin, horny, spiral, usually circular, with a central nucleus; head with short, broad snout, long tentacles and simple eyes; radula well developed; three to five fleshy cirrhi on each side of mantle margin; one gill, the left; eggs laid on rocks or glued to seaweed in masses.

A large family including many genera of littoral and deep-sea forms. They are chiefly vegetable feeders, living on algæ. Chiefly tropical; the largest and handsomest species are distributed in the Pacific and Indian oceans. Some are highly coloured in handsome patterns; all are pearly inside. A little shell, pearly and opalescent, from the East Indies, is gathered in quantities to be strung into necklaces. Large specimens of top shells are favourite ornaments for cabinets; the outer shell substance is usually ground off to reveal the pearl foundation of the closely wound coils. Some species are used in the manufacture of bracelets, buttons and pearl ornaments.

Genus TROCHUS, Linn.

Shell solid, regularly conical, with high spire of many close whorls, which are usually angled and decorated with beading and bright colours in striking patterns; base of shell broad, flattened; aperture oblique, angled, with spiral operculum; columella twisted, its edges generally toothed or folded.

The genus is mostly confined to the Old World tropics.

The **Great Top Shell** (*T. Niloticus*, Linn.), the heaviest and largest of the top shells, is very striking in markings and coloration. The spire is sharp, the whorls white under zigzag radiating bands of red, violet or brown. The outer whorl flares decidedly, and has more and narrower stripes than the upper

ones. The apical coils have nodules; the outer ones are smooth. The aperture is oblique; the columella has a spiral fold above and a strong tooth below. The umbilicus is shallow. These shells are from four to five inches in diameter and a trifle less in height.

Bracelets of pearl cut from these shells are highly prized by the South Sea Island women. If solid cross-sections cannot be had, two or three pieces are fastened together with string. Five or six are worn on one arm.

Habitat.— Indian Ocean and Australian waters.

The **Acute-angled Top Shell** (*T. acutangulus*, Chemn.) of the same regions is a smaller shell; its apex is a very sharp point, and its white sides are variously streaked with bright red. Rows of small beads adorn the whorls. The shells average two to three inches in height and somewhat less in diameter.

Habitat.— Eastern Seas.

The **Toothed Top Shell** (*T. dentatus*, Forsk.) has a heavy tall spire, its coils (about twelve) armed with large remotely set knobs, which stand out perpendicular to the surface. The colour is pale, with faint and fine markings of red. There is a broad band of green or blue surrounding the axis. This species is about three inches high and two and a half inches in diameter.

Habitat.— Red Sea, Persian Gulf.

The **Common Top Shell** of the Mediterranean coasts (*T. zizyphinus*, Linn.) is regularly pyramidal, solid, glossy, with a strong rounded ridge spotted with brown at the base of each whorl. The ground colour ranges from brown to lilac, streaked in zigzag bands with brown. A full-grown specimen has a dozen coils. The animal is as vividly coloured as the shell. The prominent head has a two-lobed flap between the long tentacles. The black eyes are on short stalks. Four pairs of cirrhi are thrust out sidewise from the mantle, as the creature crawls along the sea bottom, carrying the shell erect on its back, and the operculum lying behind it on the extended foot. From low water mark to many fathoms depth this mollusk thrives, its food the seaweed. The shell measures somewhat over an inch in height and diameter of base. The lining is beautifully pearly.

A variety, *conuloides*, Lam., is found on the Atlantic coast of Europe. It shows great variability from almost smooth whorls to strong spiral ribbing, including all intermediate forms. In colouring there is little variation from the type species. The



SEA SNAILS AND TURBAN SHELLS

- | | | | | |
|-----------------------------|------------------------------|-----------------------------|----------------------------|-----------------------------|
| 1 <i>Navicella Janelli.</i> | 3 <i>Neritina communis.</i> | 5 <i>Helicina maxima.</i> | 7 <i>Nerita peleronta.</i> | 9 <i>Turbo marmoratus.</i> |
| 2 <i>Nerita tessellata.</i> | 4 <i>Neritina reclinata.</i> | 6 <i>Neritopsis radula.</i> | 8 <i>Turbo Sarmaticus.</i> | 10 <i>Turbo petholatus.</i> |



STAR SHELLS AND TOP SHELLS

- 1, 2 Long-spined Star Shell, *Astralium longispina*.
 3 Pheasant Shell, *Phasianella australis*.

- 4 The Stone Apple, *Astralium tuber*.
 5 Wavy Top Shell, *Pomaulax undosum*.

Atlantic forms are more depressed than those of the Mediterranean.

Genus LIVONA, Gray

Shell top-shaped, heavy, large, with deep umbilicus; whorls rounded; aperture roundish; outer lip sharp-edged; operculum concave outside, thin, smooth, chestnut inside, with olive green muscle scar; body fringed with numerous cirrhi.

The **West Indian Top Shell** (*Livona pica*, Linn.) is found in Charlotte Harbor, West Florida, but not in such abundance as farther south. It is a popular sea food in the West Indies and in Central America. The shell itself has some commercial value; it is sometimes four inches high, oftener smaller; when cleaned and polished it shows a beautiful greenish pearly ground with strong black wavy markings. It lives in great numbers on the rocks and coral reefs, near shore, where it may be seen through the limpid water crawling along, waving two long tentacles ahead and a fringe of cirrhi almost as long on each side of the foot. When the surprised tourist sees one of these large top shells climbing a tree (a very common sight in the islands) he may be sure that the mollusk is dead and its vacated shell is inhabited by a hermit crab.

Genus CHLOROSTOMA, Swains.

Shell conical, solid, base of columella toothed, aperture oblique, outer lip smooth within. A large genus, chiefly of Pacific coast species. It is fairly represented in the West Indies.

The **Black Top Shell** (*C. funebre*, A. Ads.) is found in the greatest abundance upon rocks on the California coast. It has a heavy black shell, with distinct swelling of the body whorl below the suture. The apex is blunt, the umbilicus closed; the aperture is lined with greenish pearl; there is a white nodule at the base of the columella. The shell is an inch in height and width.

The **Brown Top Shell** (*C. brunneum*, Phil.), also a Californian species, is a clumsy brown thimble in form, about an inch long, with markings of white on the lips and a greenish pearly lining. It lives upon kelp and rocks.

The Top Shells and Dolphin Shells

The **Snake-skin Top Shell** (*C. pellis-serpentis*, Wood) is well named. The heavy, solid shell is $1\frac{1}{2}$ to 2 inches in diameter, a little higher than broad. Its crowded coils are separated by linear sutures, and finely marked with dark patches in intricate patterns on yellow or pink ground colour. The aperture is lined with pearl; the columella bears a heavy tubercle in the middle, and a small tooth where it joins the thin lip of the aperture.

Habitat.— Gulf of California to Panama.

Genus **NORRISIA**, Bayle

Shell large, round, umbilicated, solid, smooth; spire depressed, conical; whorls few, rapidly enlarging; aperture quadrangular; outer lip sinuous, thin edged; columella sinuous. An isolated genus of one species.

Norris's Top Shell (*N. Norrisii*, Sby.) is a common species, living upon the giant kelp on rocky beaches southward from San Francisco. The dome is depressed and tipped over by the enlarged body whorl. The apex is blunt; the sculpture consists of faint radiating lines. The colour is a rich brown turning black at the mouth of the wide umbilicus which has a greenish lining rim. The lip is thin-edged. The aperture is large and lined with pearl. A shaggy coat roughens the outside of the operculum; inside it is smooth and multi-spiral, with a central nucleus.

This species is abundant about San Diego, where it is often seen in tide pools, with the strawberry-red body extended, crawling on seaweed. Shells are picked up on the beaches after violent storms. It measures one to two inches in altitude, and about two inches in diameter.

Habitat.— Southern California.

Genus **CALLIOSTOMA**, Swains.

Shell pyramidal, with beautiful colouring and sculpturing; base flattened. A large genus of unusually beautiful shells.

The **Ringed Top Shell** (*C. annulatum*, Martyn) is a specimen people are always interested in collecting. It is abundant in many places along our Pacific coast. Its shell is fragile, and can only be collected in fine weather, and then by going out in a boat and gathering the seaweed to which these delicate creatures cling.

In bad weather they sink to the bottom. Fragments are picked up on the beach, but rarely a perfect shell. The whorls are yellowish, ornamented with raised brown dots in parallel rows; the depressions between the whorls and the area about the axis are shaded with purple. The exterior is almost as beautiful as the pearly lining. Height, 1 inch.

Habitat.—California.

The largest American species is *C. canaliculatum*, Martyn, an inch and a half high. It is conical; its revolving ribs sharp-edged and separated by spiral canals, which, however, are not purple. The ribs are pale yellow or ashy, the depressions brownish.

Habitat.—Pacific coast.

The **Blue Top Shell** (*C. costatum*, Martyn) is the abundant species along the northern Pacific coast. It is conical, with a sharp apex, rounded whorls and flattened base. The whorls are ornamented by parallel yellow riblets separated by brown depressions. The aperture is round and beautifully pearly; the columella simple.

This shore-dwelling species has a heavy shell. A dilute acid bath and a scrubbing removes the outer layer and exposes the blue pearl that forms the shell substance. The living mollusks crawl on rock surfaces exposed by the tide, but remain in the dark if possible. Length, $\frac{3}{4}$ inch.

Habitat.—California northward.

C. gemmulatum, Cpr., is wound with strings of granules, each whorl bearing two principal rows, and many small ones. The gray surface is streaked with dark brown from the apex downward. Height, $\frac{1}{2}$ inch.

Habitat.—Southern California.

Several recently named species have been discovered by collectors dredging in deep water off the California coast. All are easily recognisable as top shells by their characteristic form.

The **Pearly Top Shell** (*C. occidentale*, Migh. and Ads.) of the Maine coast is strongly ribbed, with a row of white dots ornamenting the pearly surface of the upper half of each whorl. It is but half an inch long, and is only obtained by dredging in gravel off shore.

The Top Shell of Florida and the Carolina coast is *C. euglyptum*, A. Ads., a regular pyramid, $\frac{3}{4}$ inch high, with a solid

The Top Shells and Dolphin Shells

columella. The surface is white overlaid with brown and purplish spots; the ribs set with rows of small white enameled beads. It occurs as far north as Cape Hatteras, and follows the coast to Texas and Vera Cruz.

Many other species occur on our Atlantic coast, but they are either rare or are deep sea forms, not often collected.

C. granulatus, Born., of European seas is a thin, delicate species, with exceedingly sharp peak, inflated base, and whorls closely sculptured by thread-like riblets; those next to the sutures are set with fine beading, which gives the surface a granular appearance. It is also shiny, with pinkish ground freckled with brownish yellow. The pearly substance is easily exposed by rubbing off the outer layer with a rag dipped in dilute acid. An inch or more in altitude, it is the largest granular species to be found in Europe.

The **Tiger Top Shell** (*C. tigris*, Martyn) is two inches in altitude, and banded with tawny colour on the paler and fine granular whorls. It has a depressed spire with an abruptly sharp point, and flares at base into an unusually large body whorl. The bright colouring and striking pattern of the shell will keep it always a cabinet favourite. New Zealand, Australia.

Genus MARGARITA, Leach

Shell very small, thin, depressed, globose, with smooth or cross-striated whorls; aperture circular.

The **Wavy Top Shell** (*M. undulata*, Sby.) is a tiny mollusk, scarcely $\frac{1}{4}$ inch high. It exists in quantities along the New England coast where it is appreciated as an edible mollusk by the codfish and its relatives. It is abundant in their stomachs at various seasons. At times of very low tide the collector may look for this species among the rocks of sheltered coves. The flattened dome is made of four rounded reddish whorls. The columella has a deep, wide umbilicus; the body whorl has many folds along its outer edge.

M. cinerea, Couth., is a tiny dull greenish shell with fine lines on the lower edge of the square-shouldered whorls and strong ridges on the upper edge. Very fine and close-set oblique lines cross the ridges throughout. It is found from Cape Cod northward in shallow water.



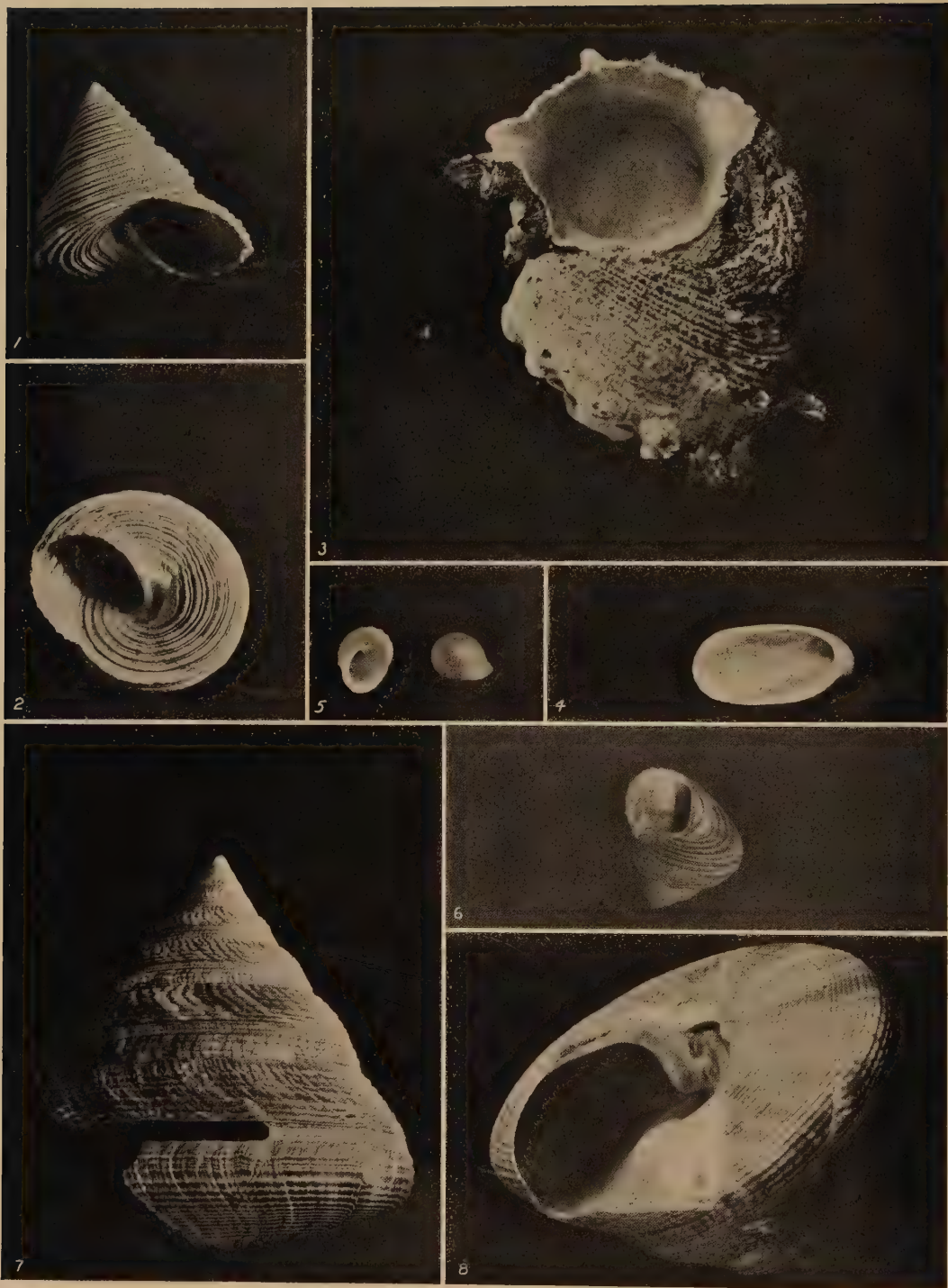
Photograph by Maxwell Smith.

TOP SHELLS

- 1 *Livona pica*.
- 2 *Chlorostoma pellis-serpentis*.
- 3 *Chlorostoma brunnea*.

- 4 *Norristia Norristii*.
- 5 *Calliostoma tigris*.
- 6 *Rotella gigantea*.
- 7 *Trochus Niloticus* (much reduced).

- 8 *Chlorostoma funebreale*.
- 9 *Calliostoma annulata*.
- 10 Rocks at La Jolla, Cal.



TOP SHELLS AND OTHERS

- 1, 2 Channelled Top Shell, *Calliostoma canaliculatum*.
- 3 Dolphin Shell, *Delphinula laciniata*.
- 4 Wide-mouthed Snail, *Gena planulata*.

- 5 Little Top Shell, *Trochatella pulchella*.
- 6 Ridged Top Shell, *Calliostoma costatum*.
- 7, 8 Slit Shell, *Pleurotomaria Beyrichi*.

The Top Shells and Dolphin Shells

M. helicina, with thinner, more bulging shell, is found on northern coast, feeding on the green *Laminaria* leaves. Its shell is very small, about $\frac{1}{4}$ inch in two dimensions, distinguished by its yellowish or olivaceous colour and iridescent, metallic lustre.

Habitat.— Maine, Alaska and northern Europe.

THE DOLPHIN SHELLS

Genus DELPHINULA, Lam.

Shell of a flattened top shape, solid, heavy, with large round aperture and deep umbilicus; body whorl turns downward, nearly free from the one next to it; all whorls keeled and spinose or set with horns.

The **Fringed Dolphin Shell** (*D. laciniata*, Lam.) is a good example of a striking but not very abundant genus. The outer coil is scarcely joined to the one above it, the apex is flat, and the keeled whorls are armed with spines and hollow horns of different sizes, set in parallel rows. The ground colour is white; the projections all dark red, purplish or black. The lining is pearly. Diameter, 3 inches; altitude, 2 inches.

This Oriental species varies exceedingly in form, colour and sculpture, as does the whole genus.

Habitat.— Philippines.

CHAPTER LIII: THE WIDE-MOUTHED SHELLS

FAMILY STOMATELLIDÆ

SHELL small, pearly within, flattened, limpet-like or ear-shaped and spiral, but without holes or slit.

This family lives in tropical regions of the Pacific Ocean. Classification is likely to need revision as the living mollusks are studied. Few have ever been seen.

Within this family a series of genera show the gradations between the coiled top shell forms, with narrow mouths, closed by an operculum, through widening ear shell forms to the limpet form in which the spiral disappears. The bearing of this chain of evidence upon the problems of evolution among mollusks is obviously important.

Stomatella has a depressed spire, few whorls, a regular top shape and an operculum. *Stomatia* has a short spire and no operculum. The animal is too large for the shell. *Gena* is ear-shaped like *Haliotis*. *Broderipia* illustrates the limpet form of shell in this family. The shell has an apical hook at the posterior end. It is shaped like a sugar scoop.

CHAPTER LIV: THE SLIT SHELLS

FAMILY PLEUROTOMARIIDÆ

SHELL top-shaped, pearly within, with a broad anal sinus in the outer whorl which closes gradually, forming the "sinus band." A family of many fossil forms allied to Haliotidæ.

Genus PLEUROTOMARIA, Defr.

Characters of the family. Eleven hundred fossil species of this genus are known. The recent discovery of living forms corrects the old opinion that the genus is totally extinct. Twenty good specimens have been collected in the past fifty years. They are large, and so distinct in kind as to be in great demand among collectors. The single specimen of *P. Quoyana*, F. and B., was purchased by an amateur in 1873 for 25 guineas. A fine large *P. Adansoniana*, Cr. and Fisch., is priced at £100 sterling. Both of these species have been found in the region of the West Indies. The American Museum of Natural History has a three-inch specimen of *P. Beyrichi*, Hilgendorf, which was dredged in deep water off the coast of Japan. It is decorated with yellow and red in fine streaks on its top-shaped spire, and the sinus band ends in a deep slit at the upper (sutural) edge of the lip. The largest *Adansoniana*, taken alive from water one hundred fathoms deep off Guadaloupe, measured more than five inches across.

The **Little Slit Shells** (genus *Scissurella*) are very small, thin-shelled mollusks with the tell-tale slit in the shell's lip.

CHAPTER LV: THE EAR SHELLS. ABALONES

FAMILY HALIOTIDÆ

SHELL pearly, ear-shaped, shallow, spiral, with outer coil very large, enclosing the body; aperture large, oval; operculum wanting; left side of shell punctured by a curving row of holes; muscle scar large, horse-shoe shaped; foot large, fleshy, fringed; mantle slit along row of holes, tentacular gill filaments passing out at each hole; tentacles two, long; eyes two, on short stalks. Habitat, rocky shores. Distribution: California, Japan, Indian Ocean, Africa, Australia and adjacent islands. One species in European waters.

The large shells furnish mother-of-pearl of commerce; foot edible; dried and used for food in the Orient. A single genus of many species.

Genus HALIOTIS, Linn.

"Where is the other half?" you inquire, when first introduced to the abalone shell.

"There is none. It is not a bivalve shell, like the clam's, but a univalve, like the snail's," is the reply.

"Then how does the animal manage to keep its body in this inverted saucer?"

"That great scar in the middle of the saucer is the place where the body grows fast to the shell. Then there is considerable support given by the inturning rim on the left side, and under the coil."

"How do you know which is the left side?"

"The living mollusk thrusts his head out under the edge of the shell just where the row of holes ends. A pair of long tentacles, two eyes on short stalks and a central broad snout are the five prominent features. The tip of the broad foot is pointed backward, from under the spiral. All around outside of the edge of the shell is the fleshy, fringed margin of the mantle. The

creature walks on the under surface of its body. Its grip on a flat surface is astonishingly powerful."

"What are the holes for?"

"Through them are thrust long feelers from the mantle. Water which has bathed the gills is thrown out through these openings. The hindermost one is the anal aperture, discharging the waste matter from the intestine."

"How do some holes happen to be closed?"

"In young shells there are no open holes. Gradually open ones are added as the shell grows. As new ones are formed, the oldest are closed by deposits from within, always leaving a certain number open."

"How old is this shell?"

"Who knows? The holes are not a record of the years it has lived."

"What does the Abalone feed upon?"

"Marine vegetation scraped from the rocks by means of the large rasping tongue."

"Is the shell naturally so highly coloured and polished?"

"Only inside. The lining, pearly and iridescent and lustrous, is *nacre*, secreted by certain glands in the mantle. A rough, horny coat covers the shell on the outside, and, by its resemblance to the rocks among which the ear shell lives, protects the mollusk from discovery by its natural enemies, large sea birds and rats. Under the horny layer is usually a calcareous one. The shells may be cleaned of this outer layer by the use of acids and by grinding."

An abalone shell is one of the handsomest as well as one of the largest cabinet specimens obtainable from North American beaches. It is well named, "the aurora shell" and "the rainbow shell." The finest species of ear shells are found on the California coast. There the euphonious name "Abalone" is universally used. The mollusk is an important article of export. The shells furnish high grade mother-of-pearl. The muscular foot makes delicious soups and chowders, as almost any Californian will tell you. Yet few are consumed in this country in comparison with the vast numbers that the Chinese and Japanese fishermen catch, salt and dry for shipment to China, where this is a staple sea food. We hear tales of luckless "Chinks" drowned by the rising tide, their hands caught and held as in a vise between the rock

and the abalone's strong foot. This is very unlikely to happen. The Chinese fisherman goes out in a boat at low tide, and inspects the crevices in the rocks to find these mollusks. Sighting one, he gives it a sharp shove with a metal wedge fastened on the end of a pole. Dislodged by this unexpected attack, the creature is easily taken in with a boat hook.

In his native haunts the abalone clings with a death grip, if only he has warning. It is impossible to tear him from his place. When undisturbed the creature lumbers along with a clumsy, swinging gait, not unlike that of an elephant. He makes the best time on the surfaces of smooth rocks.

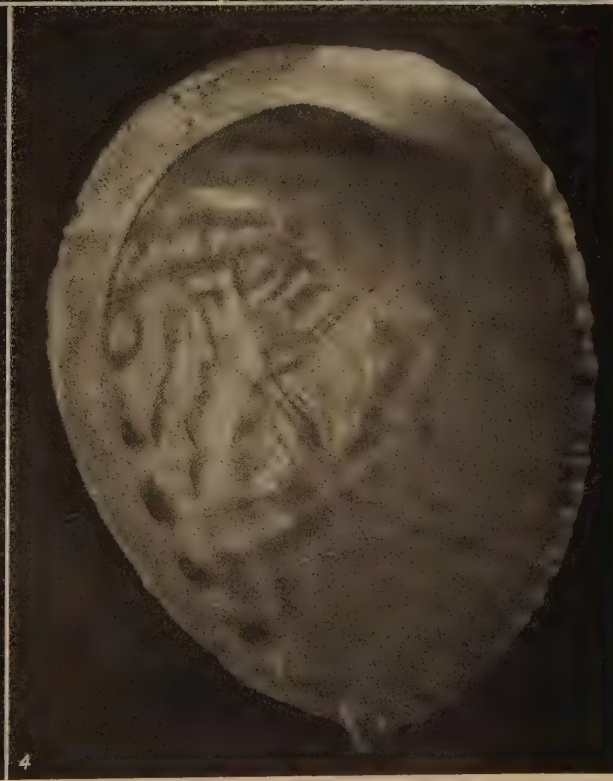
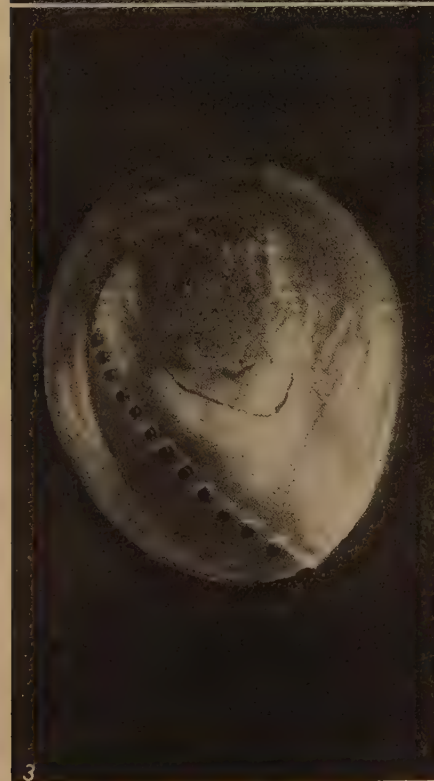
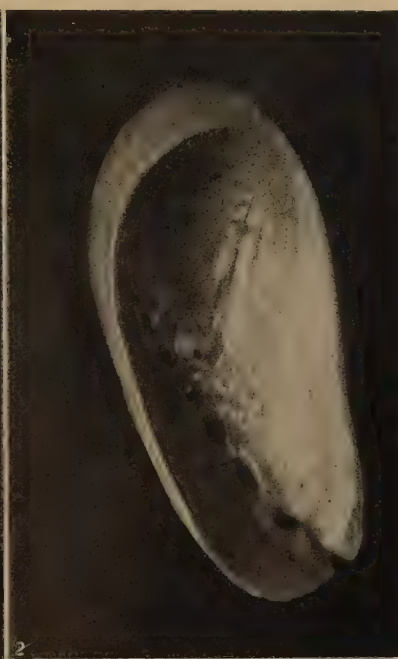
Fine green pearls are sometimes found in the mantle. An ingenious experimenter trepanned the shell of several large abalones, and inserted small pearl beads next to the mantle. Then he closed the holes with cement. Later he found all the beads coated, and thus transformed into pearls; some were of fine quality. Of course the longer they are allowed to remain the better they become.

Quantities of shells are exported to Paris and other European centres for use in inlaying in cabinet work, and for ornaments and buttons, and a multitude of small articles, like knife handles, fans, card-cases and pieces of jewellery.

The **Splendid Ear Shell, or Abalone** (*H. fulgens*, Phil.) is found on the coasts of Southern and Lower California. *H. splendens*, Rve., is a synonym. It is a thin elongated oval shell, 7 to 8 inches long, with a pearly lining that is indeed splendid as a peacock's tail, especially the roughened central patch, the muscle scar. The outer surface is uniformly dull brownish in colour, and faintly ridged with spirally radiating undulations, crossed by smaller and close-set rounded ridges. Each hole is elevated into a tubercle. From five to seven remain open. The closed tubercles are worn, as is also the depressed spire. The left side bears a flat pearly shelf, the *columellar plate*.

These shells when cleaned by acids and scraping, are as beautifully pearly outside as within. They are favourite mantel and cabinet ornaments, the most brilliant object the curio-dealer shows to the eager souvenir hunter on the west coast.

The **Red Abalone** (*H. rufescens*, Swains.) is larger and much heavier than *H. fulgens*. It is the chief commercial mother-of-pearl shell of the California coast. It often attains a length of nine



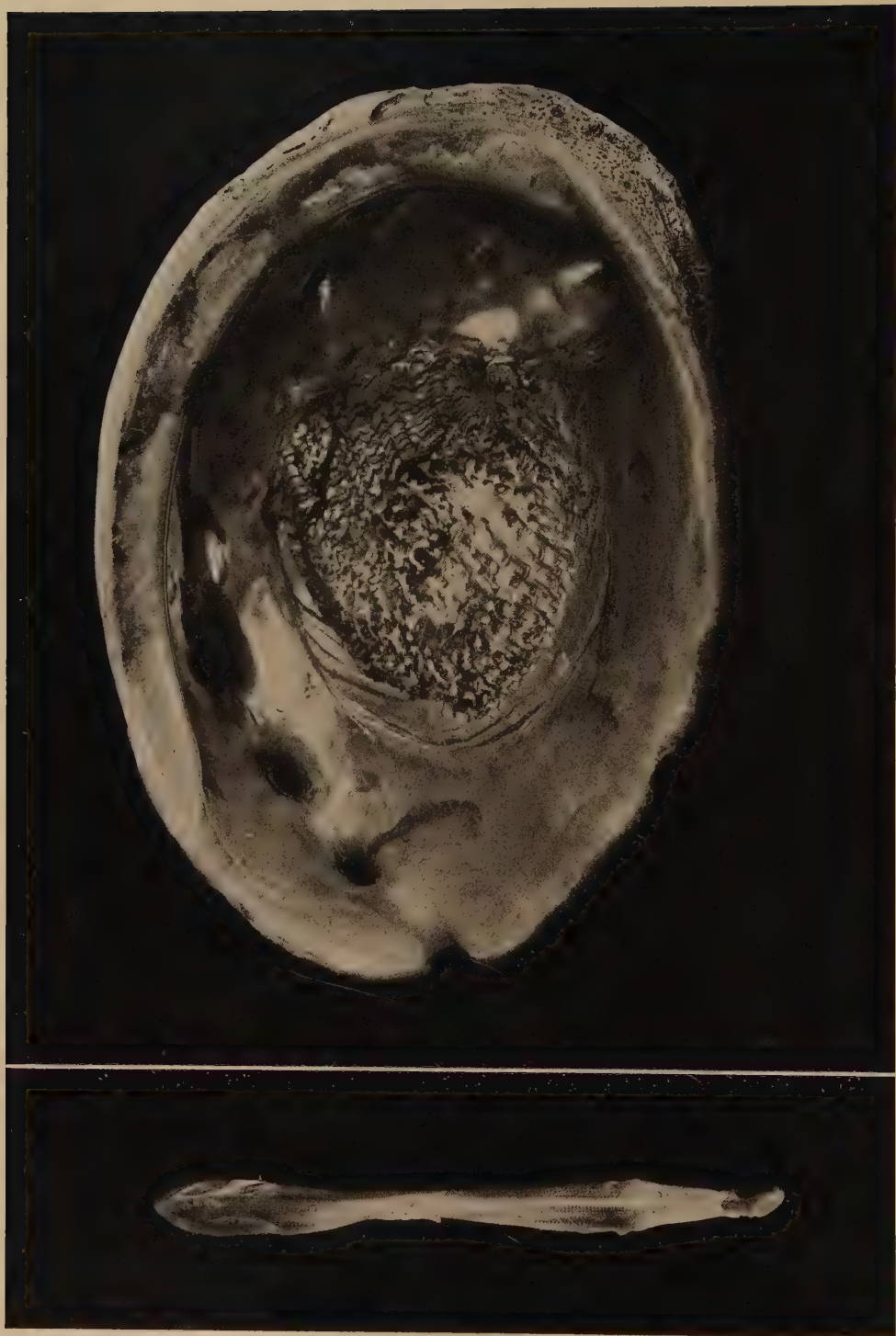
EAR SHELLS. ABALONES

1 *Haliotis corrugata*.

2 *Haliotis asinina*.

3 *Haliotis Cracherodii*.

4 *Haliotis gigantea*.



THE RED ABALONE, *Haliotis rufescens*

Radula, or rasping tongue, life size, showing the minute teeth, in transverse rows.

inches. Its pearly lining abounds in green and pink tints. The exterior is brick red, with lumpy surface finely sculptured with radiating and cross ridges. The holes are large and elevated; usually four are open. These shells are often polished outside, and sold for cabinet ornaments. The flesh is boiled in sea water, then dried on the rocks for export to China; the shells are shipped in quantities to Europe for use in button-making, for ornaments and for inlay work. The Smithsonian Institution has a large collection of treasure boxes taken from the graves of Indians on San Nicholas Island. Two handsome shells, sealed together with asphaltum, contained trinkets belonging to the dead.

The **Black Abalone** (*H. Cracherodii*, Leach) is black outside, with shadings of purple or green. The lines of growth are its only sculpturing. The shell averages five inches in length, four inches in width and two inches in height. It is less shallow than the two species just described. The holes are small and not elevated; about eight are open. The pearly lining is thick and smooth, with silvery lustre and green and pink reflections.

This species is abundant on the rocks along shore from the Fallerone Islands to San Diego, Cal. Young ones exhibit very interesting habits of life when kept in jars of sea water.

The **Rough Abalone** (*H. corrugata*, Gray) of Catalina Island, San Diego and southward, is often six inches long. Its shell is wrinkled and knobbed outside, and the holes are much elevated. But four are open. There is a row of nodules parallel with the tubercled row of holes and below them; a deep channel separates the two series of tubercles. The lining is wavy and brilliantly iridescent. The thin epidermis is brown or greenish, often handsomely banded.

The **Giant Ear Shell** (*H. gigantea*, Chemn.), 7 to 10 inches in length, is the largest known species. It is reddish outside, the thin leathery epidermis raised in wavy folds along the lines of growth. The row of pronounced tubercles has five open holes. The lining is wavy, with unusually beautiful iridescence.

This is the "Awabi" of Japan, valuable not only for inlay work and mother-of-pearl articles curiously fashioned from the shells, but a staple article of food. Sir Edwin Arnold, writing his book, "Japonica" in Enoshima, where the awabi is taken in great quantities, says: "A strip of the membrane of this is put into the folded coloured paper—*noshi*—which accompanies

all Japanese gifts, the mollusk in question being the symbol of long life and prosperity."

H. Kamschatkana, Jonas, ranges along the coasts above Japan, crosses Behring Straits and follows our Pacific coast to Monterey, Cal. It is probably a variety of the preceding species, smaller, with more pronounced lumpiness on the outside of the shell, with four open holes, a many-coloured epidermis and a silvery pearly lining. It seems to be the connecting link between the Japanese and West American species.

The Ormer, (*H. tuberculata*, Linn.), inhabits the Channel Islands, and follows the coast of Europe southward to the Canaries. It is regularly oval and very shallow, three or four inches long, mottled green and brown above, finely striated with the lines of growth and waved across them. The angle of the shell bears a row of six open holes in tubercles which are but slightly elevated. The muscle scar is inconspicuous; the pearly lining silvery, iridescent. The mantle border is elaborately decorated with a filamentous fringe which forms a considerable extension beyond the margin of the shell.

This is the "Sea Ear" of English collectors, the "Silieux," (six eyes), of the French fishing villages. In the "kitchen middens" this is a noticeable species, showing that the muscular foot was an article of food among European aborigines. Necklaces were also made by stringing perforated bits of the shell. Farmers on the Channel Islands hang strings of ormers on poles in their grain fields to jingle in the wind and gleam in the sun, and so frighten away small birds.

After being cleaned, the shells are pearly throughout, and exceptionally beautiful in form and texture.

H. asinina, Linn., is mentioned here because of its unusual shape. Its shell is greatly elongated and often kidney-shaped. It is rarely over three inches long. The elevated spire has three whorls. There are five to seven oblong open holes. The surface is smooth, greenish or ruddy, and ornamented with beads of several bright colours. The lining is pearly. The foot is prolonged to correspond with the shell. This unique species is found from Japanese to Australian waters.

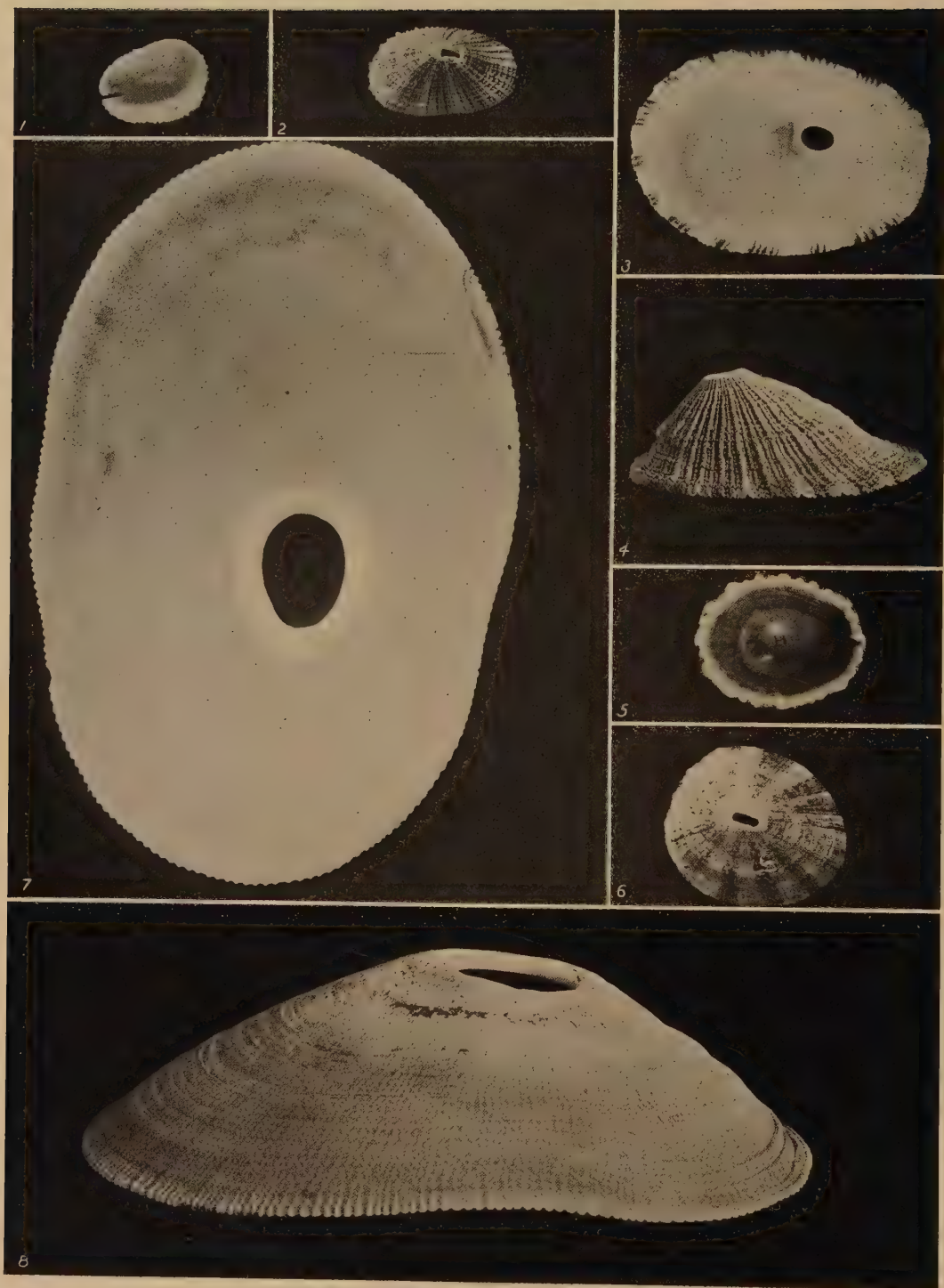
The greatest number of kinds and variation of form among ear shells occur in the Australian region. But our own west coast is the home of the species of the largest size.



No. 1 by courtesy of Automatic Button Co., Muscatine, Ia.; No. 3, photograph by Maxwell Smith.

- 1 A clam fisherman on the Mississippi River, who sells his shells to the pearl button factories.
- 2 Dead Man's Island, off San Pedro harbor, Southern California, a famous collecting ground.

- 3 A cactus fence in Southern California, under which land snails find protection.
- 4 Drying abalone meats for export to Japan. Beach near Los Angeles, Cal.



SLIT LIMPETS AND KEY-HOLE LIMPETS

1 *Emarginula Hazardi*.
2 *Glyphis alternata*.

3, 4 *Glyphis aspera*.
5 *Subemarginula octoradiata*.

6 *Fissurella volcano*.
7, 8 *Lucapina crenulata*.

CHAPTER LVI: THE KEY-HOLE LIMPETS

FAMILY FISSURELLIDÆ

SHELL broadly conical, elevated or flattened, not pearly, with apical or anterior anal slit, or hole; operculum wanting; gills, a pair, symmetrical; head well developed, with short muzzle, eyes on outer bases of tentacles on rudimentary stalks; siphon occupying notch or hole; foot fleshy, with fringed border.

This large family contains more than a dozen genera and over one hundred species. The slit or key-hole distinguishes the adult shells from those of the limpets proper. In habits the mollusks are much like *Acmaea* and *Patella*.

The young key-hole limpet begins life with a spiral shell and a marginal slit. Gradually shelly matter is added which unites the margin below the slit, and the spiral seems to uncoil. It finally disappears, the slit having travelled upward and replaced it at the apex of the shell.

Genus FISSURELLA, Brug.

Shell steeply conical, limpet-like, but with hole in apex, bounded internally by a thickened band or callus; lining white, porcellanous; body when at rest contained in the shell.

The **Volcano Key-hole Limpet** (*F. volcano*, Rve.) is significantly named. Its steep cone looks like the ash crater of the typical volcano of our geographies. A touch of realism is added by the red stripes that radiate from the apical hole, like streams of molten lava pouring down the sides.

Shells of this species are common on beaches of Southern and Lower California. Very strangely, dead and worn shells are much brighter than living ones. They are ashen pink with purple rays when alive; the mantle is striped with red and the foot is yellow. They creep about on the rocks, and may be seen at low tide.

F. Barbadosensis, Gmel., I found on the Keys outside of Charlotte Harbour on the west coast of Florida. Its steep cone is

The Key-hole Limpets

strongly ribbed, with about a dozen larger ribs evenly distributed. The colouring is grayish green, sometimes tinted with pink or shaded with purple and brown. The key-hole is small and circular, with a thick green callus inside. Length, $1\frac{1}{2}$ inches.

Genus LUCAPINA, Gray

Shells large, thick, flattened, oblong-oval, finely ribbed and cross-banded, apex slightly in front of the middle, perforated by a large hole, bounded inside by a rounded callus; body large, black, like india-rubber, too big to be contained in the shell when at rest; the reflexed mantle engulfing the shell when active; edge of the mantle smooth; foot fringed; tentacles long; eyes prominent.

The **Great Key-hole Limpet** (*L. crenulata*, Sby.) is easily the giant of the family. It is four to five inches long, with a broad, apical hole, often one inch long. The thick shell is white inside and smooth. The outside shades from pale buff to gray, and is marked by small but distinct radiating ridges, crossed by many concentric lines, grouped in bands showing the stages of growth. The finely scalloped border is the shell's chief beauty.

Keep describes the mammoth creature that finds this shell inadequate to contain it. It resembles a brick in form and size. The huge foot is yellow, with the black mantle outside.

Habitat.—Monterey to San Diego, California.

The **Two-spotted Key-hole Limpet** (*Megatebennus bimaculatus*, Dall) is a common shell on beaches from Monterey south. It is strongly ribbed from the large apical hole to the margin, and white except for two triangular spots of black on opposite sides.

In form this little limpet shell resembles that of the giant Lucapina. The animal, however, is much smaller in proportion, though the mantle is able to cover the shell completely. Length, $\frac{1}{2}$ inch.

Habitat.—California.

Genus GLYPHIS, Cpr.

This genus is separated from Fissurella (which its shell resembles externally) by the sudden posterior cutting off square of the callus that bounds the apical hole inside the shell. The

central tooth of the radula is wide. It is by internal characters proved to belong in the group with *Emarginula*, which has the apex usually closed, with the slit between it and the margin. The little "chopped off" end of the inner rim of the hole is the sign by which shells of this genus are best recognised.

G. alternata, Say, is the common key-hole limpet of the Atlantic coasts. It is an inch or more in length, with a much elevated peak, and a very finely and distinctly ribbed surface. The ground colour varies from pale dingy yellow to grayish brown, and there are usually eight dark radiating stripes ornamenting the shell. The lining is white, with a deep pit back of the apical key-hole.

Habitat.—Chesapeake Bay to the West Indies.

The **Rough Key-hole Limpet** (*G. aspera*, Eschs.), a peaked key-hole limpet of the Pacific coast, is the largest species of its genus; the oval shell is over two inches long. Its dirty white exterior is radially streaked with regularly widening dark bands, and ridges that have thin, sharp blades. The apical hole is almost round, and very thick-walled.

Habitat.—Sitka to Monterey Bay.

THE SLIT LIMPETS

Genus EMARGINULA, Lam.

Shell oval, conical, like a clown's pointed cap, with narrow vertical slit in from the front margin. Cabinet specimens, however small, can be easily traced to their proper genus by their limpet shape and this peculiar slit. The few North American species are found on the Florida Keys.

Genus SUBEMARGINULA, Blainv.

Shell roundish oval; apex high, near middle, curved backward; surface radially ribbed; anal slit a short marginal notch, with internal groove leading toward apex. Southern Florida has two species. The genus is well represented in the West Indies, and in all the archipelagoes of tropical seas.

S. Rollandii, Fisch., is a little shell with radiating ribs

The Key-hole Limpets

almost uniform in size and daintily beaded. The slit is deeper than in most species, a clear identification. Colour, pale flesh tint or green, with white rays. Length, $\frac{3}{4}$ inch.

Habitat.— Florida, West Indies.

SHIELD SHELLS

Genus SCUTUS, Montf.

Shell oblong, depressed to platter form, thick, squarish at ends, with obscure notch in front margin; apex obscure near posterior end, pointed backward; surface without radiating ribs or markings; body black or blotched with black; mantle enveloping the shell; snout and tentacles long.

S. anatinus, Donovan, is three inches long, its shell buff in colour, with white lining, marked with orange or reddish stains. It is an Australian mollusk and interesting as a type of the most primitive genus in its family. It has no key-hole nor slit nor groove; these characters have been progressively acquired by the family in course of its evolution.

The **Giant Shield Shell** (*S. gigas*, Martens) is pale yellow, with strong concentric waving lines and projecting edges on its thick shell. It is nearly four inches long, and three inches wide. Under the name of *saru-awabi* it is taken from the waters of Northern Japan and used by the natives as a staple sea food the year round.

CHAPTER LVII: THE LIMPETS. TENT SHELLS

FAMILY ACMÆIDÆ

SHELL bowl-shaped, conical, with the apex a little in front of the middle, not spiral at any stage of development; with distinct internal border of the aperture; lining never iridescent; a free branchial plume at left above neck; radula lacks middle teeth. Mostly marine mollusks living on seaweed and rocks near shore.

Genus ACMÆA, Eschs.

The structure of a limpet may be made out with little trouble, for an animal that lives in such a shell cannot be very secretive as to the arrangements of its "in'ards." Slip a knife blade under the shell and it rolls off the rock into your hand. The branchial plume, extended at the left side of the neck when the limpet travels, is drawn in, but not concealed. The central, muscular disk is the foot, which has very remarkable tenacity when affixed to a rock face. In front the short head with its mouth and pair of tentacles appears; encircling all is the mantle border, lining the shell. From the mouth of a dead specimen draw the toothed radula, and examine the series of teeth under a good magnifier. This is the organ which rasps the algæ from the rocks.

What a safe shelter is the arching roof under which this mollusk lives! Yet to breathe, the shell must be slightly lifted. This gives watchful and hungry crabs and sea birds their only chance to catch limpets unawares. They are quick to save themselves when warned. But many pay for their inattention with their lives.

Should the strongest arm endeavour
The limpet from its rock to sever,
'Tis seen its loved support to clasp
With such tenacity of grasp
We wonder that such strength should dwell
In such a small and simple shell.—*Wordsworth*.

The **Tortoise-shell Limpet** (*A. testudinalis*, Müll.), common on the Maine and Alaskan coasts, reaches 1½ inches in length,

but in the British Isles it is smaller. Brown and green stripes radiate from the apex, crossing concentric circles of white and black on the gray ground in a more or less irregularly tessellated pattern. The lines of growth are rather strong, and the surface is finely sculptured with striæ that cross each other. Within the aperture there is a brown and white tessellated border, then a white lining with a large owl-shaped patch of brown, the muscle scar, under the apex.

This sluggish mollusk wanders forth to feed on the soft tissues of algæ. It returns to its own place on the under side of a rock after each excursion.

Var. *alveus*, Conr., is so thin that the checkered pattern is seen through the wall. The sides are compressed to fit the shell to the stems of seaweeds on which it lives. The elevated peak sometimes forms a forward-pointing hook.

These, like the typical tortoise-shells, are found in cold waters on both Atlantic and Pacific coasts of North America, along with forms that intergrade between them.

A. candeana, Orb., a Floridian species, has seven to nine rays of black running down the gray or buff sides, or the black spreads in more numerous, finer rays. Five lines of black cross the narrow inner border. The ovate shell is depressed; the surface cut by radiating striæ. Length, 1 inch.

Habitat.— West Florida, Bahamas.

The west coast of the United States is particularly rich in species and varieties of this genus. I will not describe all of them, but select the most common and distinctive.

The **Plate Limpet** (*A. patina*, Eschs.), modified forms of which show it to be closely related to *A. testudinalis*, is the most characteristic limpet of the west coast. The shell is flattened, the blunt apex near the middle; the back is gray, finely tessellated with black. The flesh is white. Length, 2 inches.

Habitat.— Aleutian Islands to San Diego, Cal.

The **Rough Limpet** (*A. scabra*, Rve.) is sculptured with close, radiating, scaly ridges diversified regularly by ribs of greater size and elevation. Yellow with faint brown markings is the usual colouring. The apex is low, the slopes convex. The flesh is black.

Var. *limulata*, Cpr., has a black band around the apex, and a black border inside the aperture. The rest of the interior

is olive green. A cap-shaped form, with coarse sculpturing is the extreme of variation in this species. Length, $1\frac{1}{2}$ inches.

Habitat.—California.

The **Ghost Limpet** (*A. spectrum*, Rve.) has a ghostly print of a human hand showing under the white callus that lines the shell. Outside, strong rough ridges run from the peak to the crenulated margin. They are whitish, with dots of brown filling in the depressions. Shell heavy. Length, $1\frac{1}{2}$ inches.

Habitat.—Sitka to Lower California.

The **Mask Limpet** (*A. persona*, Eschs.) has its beak bent forward until it is parallel with the base, and almost above the anterior edge of the shell. Behind the apex the curve is rounding. Thus the shell has almost a perfect mask form. Strong rounded ridges, with wide flat spaces between, radiate from apex to margin, crenulating the latter. The colouring varies from olive green to black, with speckles or stripes of white.

From San Francisco north and south the type diverges, becoming more strongly ribbed behind the apex as we go north, and tending to smaller and narrower ribs and more spreading sides as we go south. It is an exceedingly variable species. Length, 1 inch.

Habitat.—Sitka to Lower California.

The **Shield Limpet** (*A. pelta*, Eschs.) has an oval, shield-shaped shell, with pointed apex near the centre, and low, coarse ribs radiating from it. A narrow black band follows the edge of the lining, which is oftenest made up of scallops or disconnected square spots. The peak is more elevated than usual in a small form found near Olympia, living on the valves of mussels. The typical colouring is gray, striped with black, often tessellated. Length, 2 inches.

Habitat.—Aleutian Islands to Southern California.

The **White Cap** (*A. mitra*, Eschs.) has a creamy smooth shell, rounded up to a decided peak. The dead shells are often picked up on Pacific beaches, but the mollusk is rarely seen alive. It is scarcely an inch in height, and slightly more than an inch across the almost circular base.

THE OWL SHELL

Genus SCURRIA, Gray

Shell large, oval, depressed, apex far toward front margin, radiating ridges obscured, except near margin, back brownish

The Limpets. Tent Shells

gray, spongy, eroded, lining polished, darkest colour in bands from margin inward, centre brown and white. Scar of muscle horse-shoe shaped.

Animal with the left branchial plume, as in *Acmaea*, and in addition a branchial cordon extending around the foot.

The **Owl Shell** (*S. gigantea*, Gray, *Lottia gigantea*, Gray), is the largest and handsomest limpet on our west coast. Young specimens have low and rounded tubercles set in curving, radiating rows on the back of the shell. In such the colouring is bright, a dark and light mottling of olive brown. The name comes from the shape of the muscle scar inside the dome, which has the outline of an owl.

The shell is 3 to 4 inches long, 2 to 3 inches wide, 1 to 1½ inches high.

Habitat.—San Francisco to Panama.

OLD WORLD LIMPETS

FAMILY PATELLIDÆ

Shell conical, without distinct internal border; for gills a row of secondary branchiæ are substituted, set in a ring between mantle and foot; jaw and radula well developed.

A large family sub-divided upon such obscure and difficult characters as the teeth of the radula, and the branchial cordon.

Genus PATELLA, Linn.

Characters of the family. Shell lining almost translucent, somewhat fibrous in texture, iridescent.

Patella, when young, has a nautiloid shell, but it is a remarkable fact that we are entirely ignorant, in this commonest of mollusks, of the transition stages which convert the nautiloid into the familiar conical shell.—*Cooke*.

The European limpet chooses a spot on the surface of a rock as a place of residence, and there it sinks and smooths a shallow pit exactly fitted to its shell. We are still guessing how the creature clings with a tenacity that sustains a weight of thirty pounds before the hold gives away. Back to its own place at nightfall comes the individual after ranging over the rocks to

feed upon minute vegetation that grows on them in patches. A peculiar noise is made by the scraping of the rock surface by the radulas of many feeding limpets. At rest this remarkable toothed tongue is coiled like a watch spring. Still louder is the rasping sound of limpets dragging their shells over wet barnacle-covered rocks, between tides.

Instead of having true gills, like those of its near relatives, this limpet has these reduced to mere stumps, and replaced by a series of gill plates, encircling the mantle. With these breathing organs the mollusks are able to remain for hours out of sea water, and to be exposed to rain without inconvenience. The oyster catcher deftly pries their shells from the rock with its case knife bill.

We shall find limpets of this genus in collections but not on our seashores. They have a wide distribution in the eastern and southern hemispheres.

The **Common Tent Shell** or **Limpet** (*P. vulgata*, Linn.), found from the Arctic shores to Spain, is a solid, conical shell, its peak a little in front of the centre. Ribs radiate from apex to margin; small ribs, and still smaller striæ, lie between the cardinal ones. Colour varies from grayish brown to yellowish. All are streaked or mottled, and become worn or overgrown with nullipores when old. The linings of the shells are polished and often opalescent, sometimes brighter in colouring than the exterior. Length, 1 to 2 inches.

Habitat.—Europe.

The **Rusty Limpet** (*P. ferruginea*, Gmel.) is very heavy, and deeply sculptured into rounded pillars or ridges that radiate from the apex, and make the margin deeply notched. Concentric striæ cross these ridges. The back is rusty brown, shaded with white in wavy lines. The lining is white porcelain. Length, 2 to 4 inches.

Habitat.—Mediterranean.

The finest specimens of tent shells are found in far off tropical regions. *P. longicosta* from the Cape of Good Hope, has the ridges of its heavy shell prolonged into thin blades. *P. granularis* has its peaked roof beset with stout prickles. The flat yellow back of *P. aspera* of Madeira bears a set of radiating saw-toothed ridges as sharp as knife blades. *P. radians* from New Zealand has a flattened, almost smooth, finely mottled exterior

with a shell lining like smoked pearl. *P. compressa* from the Philippines has its thin, yellow, finely striated shells drawn in at the sides, elevating the apex.

P. Mexicana, reported as found in Mexico and Central America, is the giant of its family—of all the limpets. Its shell is ponderous, bowl-shaped, and from six to fourteen inches long. It is often used as a wash basin in Central America. The lining is white and hard, like porcelain. The live animal is black, streaked with white.

P. pectinata, Born., is typical of the cap-shaped limpets, in which the apex points forward and the slope behind it is decidedly curved. Its ribs are black, and prickly, with buff or pink valleys between. Length, 1 to $1\frac{1}{2}$ inches.

Habitat.—Cape of Good Hope.

Limpets of this shape are often called "clowns' caps." Among the key-hole limpets genera of cap-shaped shells are also found. The "white cap" in *Acmaea* also has this form.

CHAPTER LVIII: THE CHITONS. COAT-OF-MAIL SHELLS

ORDER POLYPLACOPHORA

SHELL composed of eight overlapping plates, supported by a muscular, leathery girdle, which extends beyond the plates and folds under, forming the margin of the convex body shield; body flattened, oval; foot, the whole ventral surface of the body; mantle encircles the body; gills, multiple, forming a continuous fringe between mantle and foot; head distinct from body; tentacles wanting; eyes mostly wanting; radula well developed; sexes distinct; reproductive organs paired; eggs laid in ropes or clusters; kidneys paired. Mollusks nocturnal, sluggish in movements, curl up when disturbed; subsist chiefly on vegetable diet. Habitat, rocky shores. Distribution, world-wide, in temperate and tropical seas. Eaten by poor classes in some localities.

The chitons are unique among mollusks. The shell is composed of eight separate but overlapping plates. By this shell peculiarity all chitons may be instantly recognized by the most casual observer. The name, "coat-of-mail shells," is a very good one. All other mollusks have one or two valved shells, with the rare exception of shell-less forms.

The eight plates form a dorsal shield which, inverted, looks like a boat. The girdle is the leathery skin in which the plates are securely embedded. It extends beyond the wings of the shell plates, forming the thin-edged horny border of the shield. Underneath it extends to the body, which lies in the concave of the arching plates. The flat ventral surface of the body is the foot. The mantle is a muscular fold between the foot and the inner edge of the girdle. It is best seen when the foot muscles contract. The expanded foot throws the mantle into folds in the narrow oval groove. The gills are fringe-like, external, attached in the groove between the mantle and the foot. The head is scarcely more than a tapering extension of the body. It bears no

organs but the mouth. The mantle edge covers it completely, like a hood.

The chitons are an ancient family, geologically speaking. Thirty-eight genera, including about two hundred and fifty living species, are distributed over a large part of the world. Nine-tenths of these species live along shore in less than twenty-five fathoms of water, feeding upon the marine vegetation of this zone. Of these forms the greatest number are found under stones, between high and low tide levels, where the bottom is oozy and muddy. Chitons are rarely found on sandy coasts. A few species venture out to 100 fathoms depth; still fewer forms are dredged in mid-ocean.

The collector of shells needs a few instructions before he goes for chitons. These curious creatures are nocturnal in habits. They congregate by night where seaweeds are decaying, and return on slow foot to rest in certain familiar rock crevices by day. When the stone to which a chiton is attached is lifted, the mollusk seems to be grown fast to it, so strong is the suction of the broad foot. A quick thrust of a blunt knife under the shield is necessary to dislodge it. The disturbed mollusk will curl up into a ball, like a pill bug, if handled now. No use to try to straighten it by force. The stubborn muscles will break before they will relent. But drop the specimen into a bucket of salt water, and it will soon assume its natural position.

The business-like collector goes prepared, carrying small, smooth wooden slats and a ball of soft cotton twine. He deftly slips the specimens, one by one, to a place on the wet slat, to which they gratefully attach themselves, and are promptly bound with coils of the twine. Thus they are dried in proper position for museum or cabinet specimens.

The girdle is a muscular belt, which helps to hold the plates in place, and forms the margin of the shield. The leathery covering is variously coloured and marked. It may be striped or marbled, with smooth, horny surface, or covered with down, or scales, or tufted hairs, or stout limyspicules and knobs, like the sea-urchins. Sometimes the margin has a deep posterior slit or notch. Sometimes the width is so great that the plates are entirely covered over by the girdle. In other forms the girdle is narrow.

The Californian coast is the best place to study chitons alive. The greatest variety to be found in any one region is



LIMPETS, CHITON AND SHIELD SHELL

1, 2, 3 White Cap Limpet, *Acmaea nitida*.
 4, 5 Ribbed Limpet, *Acmaea scabra*.

6, 7 File Limpet, *Acmaea scabra*.
 8 Chiton, *Katharina tunicata*

9, 10 Duck-bill Shield Shell, *Scutus anatina*.



THE GIANT CHITON, *Cryptochiton stelleri*

The under side of a cabinet specimen shows the eight overlapping plates, the "butterfly shells" which are often picked up on California beaches

assembled here, including some of the largest and most brilliantly coloured forms.

The **Showy Chiton** (*Ischnochiton conspicuus*, Cpr.) is a large and beautiful chiton found from Santa Barbara to Magdalena Bay. It is three to four inches long, the shell shaded green, and finely granulated, pink at the umbo of each valve, and smooth. Faint wavy bands sculpture the lateral areas; the girdle is narrow, and coated with bristles set so close as to form a velvety cover. The front valve is concave.

The **Gray Chiton** (*I. Magdalenensis*, Hds.), a smaller species with much the same range, is also found at Santa Catalina and Santa Barbara Islands. It is pale green underlaid with pink, and mottled, with radiating riblets, and the central areas have small diamond-shaped pits. The first valve is flattened, not concave, in front. The girdle is covered with fine, close scales. The foot projects forward, covering the head.

In studying the development of this species Heath found that the eggs were laid in gelatinous strings almost a yard in length, the average number of eggs contained in each string being 115,946. When six days old the young chitons enter upon the free-swimming period of their existence. This lasts but two hours. After it is spent, they settle down upon rocks or seaweed and undergo a gradual metamorphosis.

During all the stages of development passed up to the time of settling down the chiton exhibits radial instead of bilateral symmetry. The embryology of Annelid worms is similar. This seems to point back toward a common ancestor of these two groups.

The **Magnificent Chiton** (*Chiton magnificus*, Desh.) has a very large black shell, with minute blue dots scattered over it, and a blue lining. The surface of the back is smooth, with faint radiating lines. The girdle is narrow, made of shiny overlapping black scales. This handsome, smooth-shelled chiton attains the length of four or five inches, with a breadth of three inches.

Habitat.—Chilian coast.

C. Goodallii, Brod., is a large smooth chiton, often fully six inches long, with straight sides sloping up to a central peak, like the roof of a house. The colour is dark brown, the narrow girdle paler brown, made of flat overlapping scales. The lateral areas of the middle six valves are crossed by dark concentric bands or terraces. These indicate rest stations at which

growth ceased, and was resumed later. The interior of these shells is white.

Habitat.—Galapagos Islands.

C. squamosus, Linn., often three inches long, is a showy species from the West Indies. The ground colour is buff with olive tinge; the median areas of the valves are longitudinally banded with black. The lateral areas bear radiating lines of very small beads, running outward from the umbo. There is a dark blotch on each side of the keel. The girdle is scaly like snake's skin and banded alternately with dark and light olive green. The interior of the shell is dark blue green.

Three little chitons under an inch in length are found on rocks between tide marks on our Atlantic coasts. They are *C. ruber*, reddish in colouring, *C. alba*, with whitish shell, and *C. apiculatus*, with bristly points on shell and girdle. The first two species named are also found on rocks and seaweeds on the coasts of England. Iceland, too, has its chitons.

The Iceland fishermen believe that if these "sea-bugs," as they call them, are swallowed raw they will prevent sea-sickness and also quench thirst. It is probable that the cure would prove worse than the disease for most people who cross the ocean.—*Baker*.

The **Mossy Chiton** (*Mopalia mucosa*, Gld.) has two oblique slits, one on either side of the median one, in the posterior valve. The girdle is narrow and densely covered with short curling hair. The plates are brown and sculptured with lines of intersecting riblets on the lateral areas. Sometimes the colour is bright orange, scarlet or green. Occasionally it is gray. Length, 2 inches.

Habitat.—Pacific coast to San Diego, Cal.

Katherina tunicata, Sby., represents a closely related genus.

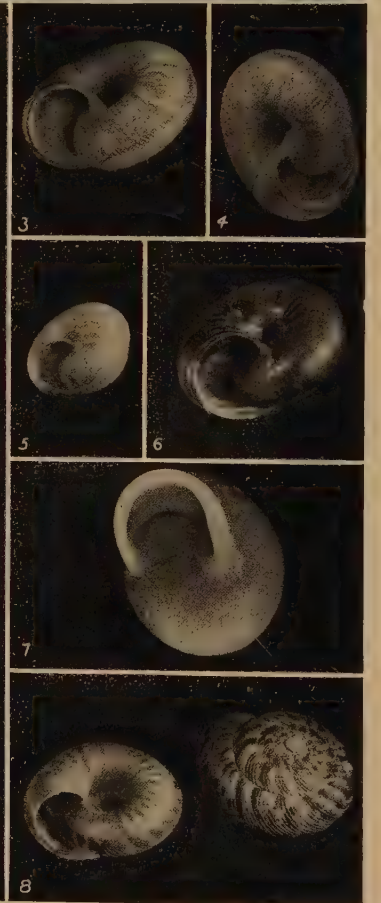
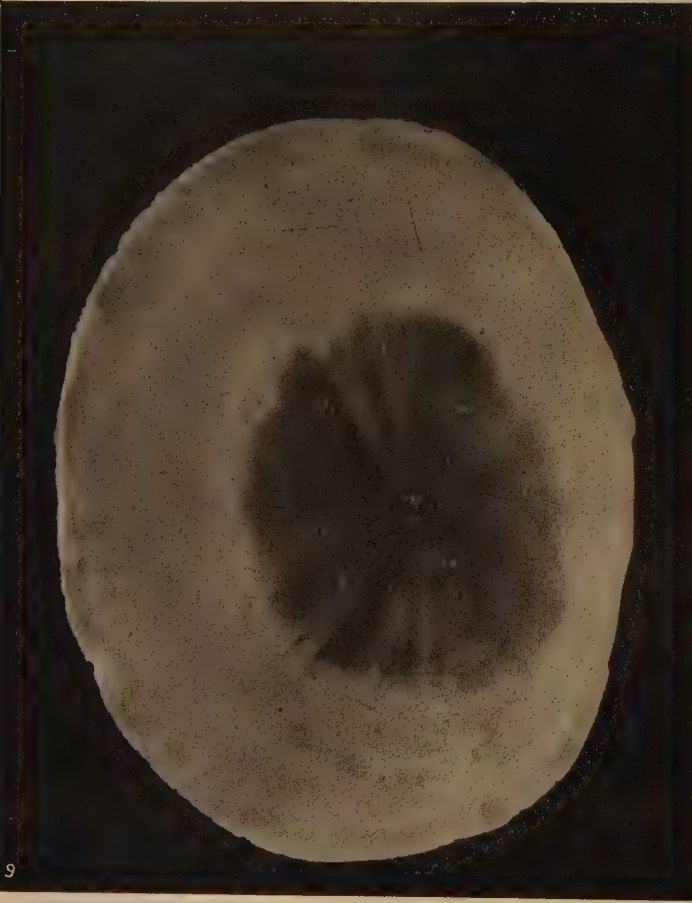
The **Giant Chiton** (*Cryptochiton stelleri*, Midd.) has its valves completely covered by the leathery girdle. It lives along our west coast, just below the low water mark, a striking object with its brown surface thickly studded with bright red spines. It varies considerably in colour. It is from six to eight inches long, oval in form, with rounded back, flat or concave underneath with a strong pedal surface attaching it to rocks. The buried valves are pale and hard, without the usual porous layer. They are the beautiful pink "butterfly shells" people pick up on shore. The Indians and Aleuts eat the fleshy parts of this mollusk raw.

Habitat.—Japan to Santa Barbara Islands, California.



CHITONS AND BUBBLE SHELLS

- | | | | | |
|------------------------------------|---------------------------|-------------------------------|---|---------------------------------|
| 1 <i>Chiton echinatus</i> . | 3 <i>Bulla nebulosa</i> . | 5 <i>Aplustrum aplustre</i> . | 7 <i>Hydatina albo-cincta</i> . | 9 <i>Hydatina albo-cincta</i> . |
| 2 <i>Ischnochiton conspicuus</i> . | 4 <i>Bulla ampulla</i> . | 6 <i>Alys Naucum</i> . | 8 <i>Haminea virescens</i> (body extended). | 10 <i>Hydatina physis</i> . |



LAND SNAILS AND UMBRELLA SHELL

1,2 *Helix Pomatia*, the principal edible snail in Europe.

3, 4 *Pyramidula solitaria*.

5 *Omphalina fuliginosa*.

6 *Gastrodonta ligera*.

7 *Polygyra albolabris*.

8 *Pyramidula alternata*.

9 *Umbrella Indica*.

CHAPTER LIX: THE SEA BUTTERFLIES

CLASS PTEROPODA

A PELAGIC group of mollusks, reaching shore only by accident, as when storm-driven. They live in communities, in all seas; the Arctic species are the most highly coloured. They rise to the surface at twilight; rarely specimens come up in daytime. They feed upon microscopic mollusks and crustaceans.

The pteropods are all small mollusks, naked or with small, transparent shells, internal or external. Some are trumpet-shaped, some cylindrical, with needle-like shells. Others are pyramidal or globular. Shells like those of the pearly nautilus, the purples and the Hungarian cap occur among the spiral forms. The foot is dilated into two wing-like swimming disks, or these disks occur as accessory organs of locomotion, the foot being rudimentary. The position of the body in swimming is "wrong side up," the abdomen uppermost. The head has tentacles which bear organs of hearing and smell, but not of sight. The large proboscis has a lingual ribbon armed with recurved spines. There are sometimes grasping organs. Gills are internal or external. Young pteropods swim by a velum until the adult swimming lobes appear. In all genera the young have shells.

The interesting genus, *Firola*, has a few species, with slim fusiform bodies, propelled by a ventral and a caudal fin. The gill rises unprotected above the tail. These creatures exhibit their entire structure without reserve. The circulation of the blood is traceable through the transparent tissues. Well developed hearing organs enable the creatures to detect enemies. Their flight is swift, and the loss of the head does not seem to deter them at all. Adults have no shells.

They inhabit the Mediterranean Sea, and the Atlantic and Pacific oceans.

Spirialis Flemingii, seen off Nahant in considerable abundance in 1863, were studied by Alexander Agassiz. He observed that they came to the surface at high tide when it occurred directly

after dusk, but were rarely seen in daytime, or after ten o'clock at night. In the aquarium they crept along the bottom by means of their wing-like appendages. In daytime they would rise a few inches, then fold their wings and drop. But by night they came up and gambolled at and near the surface, flapping rapidly about like butterflies.

Whales swallow enormous numbers of pteropods of the genera *Limacina* and *Clio*, which swarm at twilight, in Arctic seas, colouring the surface for miles.

Genus **CARINARIA**, Lam.

Shell cap-shaped, thin, glassy, brittle, covering the stalked nucleus; body large, oblong, gelatinous, with two fins, a well-developed head, eyes, tentacles and a strong snout with toothed tongue. The gills, which protrude from under the shell, are feathered.

The shells of these strange ocean swimmers were known long before the animals had been observed. One of them looks like the cap of some fairy harlequin; the peak surely ought to dangle a tassel of spun glass. Unnecessary seems the shell indeed, as the creature darts about, seizing small pelagic animals with its great proboscis.

C. Atlantica, Ads. and Rve., inhabits the North Atlantic. The shell is depressed and the apex decidedly coiled. Similar to it is the Mediterranean species, *C. fragilis*, Bory.

C. vitrea, Lam., larger, and with shell attenuated to a high, sharp peak, is found in the Indian Ocean.

Genus **ATLANTA**, Les.

Shell nautiloid, minute, glassy, compressed, keeled; aperture small, notched; operculum lamellar; animal able to withdraw into shell; gills contained in a dorsal mantle cavity; head large; eyes conspicuous; ventral fin fan-like, provided with a fringed sucker.

A. turriculata, d'Orb., is a lively little mollusk. It swims, shell downward, with sudden jerks, by means of the fin-like foot, and the tail fin. It rests when tired by attaching the disk to floating objects. "Glassy Nautilus" it was called before the structure of the soft parts was known.

Habitat.—Warm parts of the Atlantic Ocean.

CHAPTER LX: THE SHELL-BEARING SEA SLUGS

SUB-ORDER TECTIBRANCHIATA

THIS division embraces families of the Order Opisthobranchiata, in which the shell is seen to disappear by gradual changes, becoming thinner and more enveloped in folds of the mantle and foot as it diminishes in size. The right gill is usually present, but concealed by the mantle fold. The group is not well represented in American waters.

THE CANOE SHELLS

FAMILY SCAPHANDRIDÆ

Genus SCAPHANDER, Montf.

Shell scoop-like, gaping, scarcely containing the body. The tentacles are united forming a broad lobe behind the large head. The gizzard is large and very powerful, enabling these creatures to devour good-sized mollusks and reduce their thick shells. They subsist chiefly upon tooth shells, in search of which they burrow persistently in the sand.

The **Woody Canoe Shell** (*S. lignarius*, Linn.), with brownish orange surface grained like fir wood, and white lining, is the type and by far the largest of the canoe shells. Length, 2 to 2½ inches.

Habitat.—Coasts of Great Britain, Norway and Mediterranean Sea.

S. lineolatus, Couth., closely striated, yellowish, with spreading outer lip, one-half inch long, is found in Massachusetts Bay. A white one, a trifle longer, occurs in Casco Bay.

Atys Naucum is a pure white bubble-like shell in this family.

LATHE SHELLS

FAMILY TORNATINIDÆ

Genus **TORNATINA**, A. Ads.

Shell thin, inflated, cylindrical, entirely covering the animal. The spire is concealed, as in *Cypræa*. The head and foot are split; the halves are reflected over the shell. The radula is replaced by a powerful gizzard in which molluscan food is ground. So solid and compactly built do these shells seem that to Linnæus they looked as if turned on a lathe, hence the name.

T. punctistriata, Ads., a minute representative of this genus, occurs from New York to Massachusetts.

THE BUBBLE SHELLS

FAMILY BULLIDÆ

Genus **BULLA**, Linn.

Shell thin, smooth, ventricose, almost globular; spire polished, deeply pitted; lip plain; body large, fleshy, partially enveloping the shell by reflexing the two wing-like parapodia. Eyes prominent on frontal disc. Quantities of mucus are secreted by the skin to keep it moist while the tide is out.

The food of *Bulla* is molluscan; the creature burrows in the sandy mud and captures small bivalves and snails which it swallows whole and grinds to fragments between the strong walls of the gizzard. The mantle flaps are used in swimming.

The **Cloudy Bubble Shell** (*B. nebulosa*, Gld., *B. Gouldiana*, Pils.) I have often found on the mud flats of San Pedro, and watched the captive slowly stow away the viscid bulk of its great foot within the ample shell. I have washed away the slimy mud, and admired the cloudy splotching of yellow and brown on its

polished surface. I have boiled my bubble shells with the utmost care, and delicately set about extracting the fleshy parts from shells. Alas! every time they went the way of all bubbles. In fragility, as well as in form and coloration they are like the shells of certain birds' eggs. Like other collectors, I have gratefully accepted shells cleaned by the little black side-stepping crabs that throng the rocks of the breakwater and the old jetty. Length, 2 inches.

Habitat.—Southern California.

The largest bubble shell is *B. ampulla*, Linn., from the Philippines, as big as a hen's egg. The most vivid in colouring is *B. cruentata*, A. Ads., "the blood-stained Bulla," from the Moluccas.

The **Florida Bubble** (*B. occidentalis*, A. Ads.) is small, but it has the characteristic apical pit, and gaping mouth as long as the thin, oval shell. The body is large, the foot lobes turning back so as to envelope the shell almost completely. The surface is polished, minutely scored both ways, pale mottled with warm brown in a vague pattern. On the gulf coast of Florida the beach is sometimes strewn thickly with these shells after a storm. They are West Indian, and venture no further north than Florida, chiefly on sandy beaches toward the southern end. Length, $\frac{1}{2}$ inch.

Genus HAMINEA, Leach

H. solitaria, Say, is a little bubble shell, bluish white or brownish, thin and fragile, finely striated, found in muddy, sheltered bays south of Cape Cod. In the neighbourhood of Woods Holl, Mass., and along the shallow borders of Vineyard Sound it is abundant. Length, $\frac{3}{8}$ inch.

Habitat.—Atlantic coast.

H. vescicula, Gld., is a fragile, pale yellowish green species of the west coast. It has the form of the typical bubble shell, and lives in muddy shores near the mouths of rivers, mingling with a vegetable diet such small crustacea and shell fish as it is able to capture and swallow. The powerful gizzard, armed with teeth, does the rest.

The **Green Bubble Shell** (*H. virescens*, Gld.) prolongs the lip into a scoop which is quite inadequate to protect the

The Shell-bearing Sea Slugs

body. Length, $\frac{1}{2}$ inch. It is found well concealed on mossy rocks on Southern California coast.

Thin, handsomely banded bubble shells, partially internal, are included in genus *Aplustrum* and a sub-genus, *Hydatina*.

THE SEA HARES

FAMILY APLYSIIDÆ

Genus *APLYSIA*, Linn.

I met a sea hare first on the border of a coral key in southern Florida. The strange-looking object was about six inches long, a mass of mottled purple jelly, tapering to a point behind, extending forward into a small, erect head on a long neck. Two pointed wing-like flaps met over the back. Two flexible prongs stood out from the head and two smaller one from the neck. The creature swam gracefully among the seaweeds, using as propellers the broad side flaps. I ventured to capture this interesting stranger in a crab net, whereupon the surrounding water was dyed purple in an instant.

This is a reasonable defence of an animal whose shell is nothing but a transparent, flexible rudimentary plate, hidden in the soft back. Under the shell is the gill, to which water is brought by a siphonal fold of the mantle. The head is like a hare's, when seen in front.

At different ages the sea hare lives at different depths, closely imitating in colour the seaweeds and anemones upon which it feeds. When adult it has passed through several zones, and takes the liberty of ranging backward to shallower water. At breeding time the creatures flock together. The eggs are laid among seaweeds in gelatinous, thread-like cases.

The name *Aplysia* means indelible. The fluid emitted was once believed to be a poison, killing even the person who touched the animal with a stick. The Mediterranean *A. depilans* was charged with causing baldness, by a form of absent treatment. It is known now that they are all harmless creatures; the natives of the Friendly and Society Islands use kindred species for food, preferring to eat them raw.

A. Californica, Coop., rarely cast ashore by storms on the west coast, reaches fifteen inches in length.

THE UMBRELLA SHELLS

FAMILY UMBRELLIDÆ

Genus **UMBRELLA**, Lam.

Shell flattened, limpet-like, thin, calcareous; foot large, thick, notched; snout large, retractile, with lobed veil; tentacles ear-like.

Six species of marine mollusks, scarcely protected by their oblong, lid-like shells, under which the branchiæ and other delicate organs lie.

U. Indica, Lam., is as large as the palm of the hand, white and polished within. Outside it is rayed from the central apex with obscure brown bands.

Habitat.—East Indies.

The **Mediterranean Umbrella** (*U. Mediterranea*, Lam.) has its rows of short plumed gills scarcely under the edges of its flat shell, an absurdly small Chinese umbrella, compared with the inordinate development of the foot. The disk of leather that covers the palm, bears about the same relation to the padded portion of a boxing glove. Length, 3 inches.

Habitat.—Mediterranean.

CHAPTER LXI: THE NAKED SEA SLUGS

SUB-ORDER NUDIBRANCHIATA.

SHELL wanting in adults; no proper gills nor osphradium; body soft, worm-like, with many and elaborately branched tentacular processes, called *cerata*, on the back and sides; skin stiffened by spicules of lime; jaw and radula usually present.

Mollusks live in shallow water, gliding about on stems of seaweeds, feeding on algæ, mollusks or anemones, swimming, foot upward, with an undulating motion.

There is not room in a general book on mollusks to describe in detail the families of the sea slugs. A few typical examples must suffice.

The **Plumed Sea Slug** (*Æolis papillosa*, Linn.) is one of the most familiar sea slugs on the North Atlantic shores, American and European both. The back is covered with elongated papillæ, like tubular fringes, that fall away from the median line. The foot is squared in front and tapers to a point behind. The head bears two pairs of tentacles. The plumes serve a four-fold purpose: (1) they are breathing organs; (2) they contain stinging threads that the æolis shoots out at any creature that molests it; (3) they contain branches of the liver, and so help in the digesting of food; (4) they resemble the tentacles of the cave-dwelling anemone (*Sagartia*) which is distasteful to fish, and thus earn, by deception, immunity from attack. In an extremity the *Æolis* flings off a bunch of its plumes, and escapes while its pursuer is examining them. It is a small matter to grow new ones in their places.

This creature glides rapidly among seaweeds, or swims in clear water, a thing of grace and beauty, taking on the colours of the anemones and algæ it feeds upon. Its usual colouring is yellowish gray to orange, with spots of green and purple. The *Æolis* is a bold creature, never seeming to hide, but evidently trusting that memory of one stinging, bad-tasting sample mouthful is sufficient to deter a fish from attacking it. The bright

colouring serves as a danger signal, then, to all sophisticated enemies.

When the *Æolis* is full grown it is four inches long. The eggs are laid in a gelatinous cord coiled on rock faces or looped, festoon-like, on seaweeds. The young have glossy shells, coiled like that of the chambered Nautilus, which are soon absorbed. The rasping tongue has but one central row of teeth.

The **Bushy-backed Slug** (*Dendronotus arborescens*, Müll.) is covered with a forest of miniature tree forms, the elaborately branched cerata, which disguises the creature as it hides among branching corallines and seaweeds whose rosy or brown marbled colouring it imitates faithfully. This is a distinctly edible slug, from the view point of a fish; therefore protective coloration is its only defence. The adult is a little over an inch in length. No wonder it shrinks from exposure in the clear water where it would be conspicuous.

This is a very desirable addition to a marine aquarium jar. Put in a few pebbles with their tufts of bright coralline, and some ruddy algæ with their animated molluscan imitator. It is a marvellously interesting and beautiful study, but you must have a stick to poke up the shy creature.

The grove on its back serves the slug for gills. At the base of each tree is a pouch, a stomach annex, supplied with branches of the liver; here digestion proceeds. The New England coast and opposite, across the Atlantic, is inhabited by this mollusk.

The **Sea Lemon or Warty Slug** (*Doris tuberculata*, Linn.) somewhat resembles half a lemon, cut in two lengthwise. The yellowish back is warty and stiffened by limy spicules; there are gill plumes arranged in a rosette on the posterior end of the back; two leaf-like tentacles rise in front. The creature glides slowly on its flat foot, concealed by its resemblance to the crumb-of-bread sponges, which are its principal food.

The egg ribbon is wound into a remarkable rosette form, and glued to a rock. Each contains many thousand eggs. The young ones have nautiloid shells. The adults are rarely over three inches long.

D. bilamellata, Linn., is the common New England species. **D. tuberculata**, Linn., of Great Britain, is nearly as broad as long.

D. Montereyensis, Coop., of the California coast, is yellow-

The Naked Sea Slugs

ish, dotted with black, and often roughly tuberculated. It rarely exceeds three inches in length. Look for it at low tide in shallow pools or in tangles of seaweed. It is worthy of study in a jar of sea water.

It is a diverting thought, and an enlightening one, that these helpless creatures are protected by the expedient of wearing their arborescent "liver and lights" on the outside. Sea anemones are known as bad-tasting creatures, with projectile stingers which they cast at the least suspicion of attack. Hence, resemblance to anemones is a strong defence to any nudibranch. One little slug carries an anemone on its back. Many feed upon the anemones they imitate, often hiding in the capacious bodies they devour piecemeal. Those that feed upon ascidians, sea fans, hydroids and corals imitate in their branching cerata the tentacles of these creatures, as well as their colouring.

CHAPTER LXII: THE FLESH-EATING LAND SNAILS

FAMILY TESTACELLIDÆ

CARNIVORUS land mollusks are little known. They are a limited group, called Class Agnatha, the jawless mollusks.

Genus TESTACELLA, Cuv.

Shell ear-shaped, terminal, minute; animal long, slug-like, rapacious, living underground, feeding on earth worms and other mollusks.

The **Ear Shell Testacella** (*T. baliotidea*, Drap.) has the predatory habits of a tiger and a shark, showing no mercy to its prey, and ceasing only at the failing of a great appetite. Its worm-like body slides into the burrows of its victims, which it captures by a final spring. The seizing organ is the radula, set with sharp backward-turning teeth. There is nothing to save the earth-worm from this grip; its struggles fasten their hold tighter as the muscles draw it into the capacious maw. In fact, the whole pharynx turns wrong side out to thrust out the armed tongue-ribbon, and with its withdrawal the worm is swallowed whole. The stomach is stretched very considerably to contain a big worm.

In wet weather the Testacella has to come out, for it cannot endure drenched earth. In very dry weather it goes deep, even two or three feet, to find moisture, or seals its body in a waxy coat of mucus to check evaporation. It walks abroad at night, but hides by day. When captured it shows a resentful temper, frothing at the mouth, and spitting out the contents of its stomach. It devours earthworms hungrily, but only if they are alive and squirming. Its eggs are large, one-sixth of an inch in diameter. They bounce like rubber balls when dropped.

Astute gardeners bring Testacella into their greenhouses

The Flesh-eating Land Snails

to rid them of earthworms. The average person would mistake it for a slug, and thus destroy an ally, instead of an enemy.

Genus OLEACINA, Bolt.

SECTION GLANDINA

Shell large, long, with narrow aperture and elevated spire, able to contain the long, narrow body; mouth flanked by two long lip feelers, besides the two pairs of tentacles; radula as in Testacella. A group of predatory mollusks whose distribution centres in tropical America.

The greatest of land snails, the *Bulimus* of South America six inches long, with eggs as big as olives, is the helpless victim of a *Glandina*. Calculatingly the cannibal explores the aperture to make certain the shrinking creature is within. Assured of this, it makes short work of dragging it forth. Occasionally, as if to keep its teeth sharp, the *Glandina* will bore a shell through as a *Natica* would do, and suck the soft parts.

O. truncata, Gmel., lives a semi-aquatic life among the Everglades and on the Keys of Florida, ranging north to South Carolina and to the islands off the coast of Georgia. It preys upon land mollusks, chiefly *Helices*, which it bores with its "drill." It does not disdain slugs, and often devours its own kind. The shell is rosy yellow.

The largest specimens are four inches long, but the species averages one to two inches. The collector looks for them in the centres of tussocks of marsh grass close to the sea coast. The Cuban *Oleacina* excretes a bitter fluid with which it benumbs its victim before devouring it.

Ærope, the greatest of all carnivorous land-shells, lives in South Africa. It is a dull, olive brown snail, about four inches long. It is said that after a battle between native tribes great numbers of *Ærope caffra* Fér., come together from all directions, the goal being the field of slaughter.

FAMILY SELENITIDÆ

SHELL as in *Helix*. Animal carnivorous; jaw without ribs; radula well developed, rows of teeth arched.

Genus MACROCYCLIS, Beck. (SELENITES, Fish.)

Shell thin, spire depressed, wrinkled, or striated; animal as in *Helix*; eye peduncles long; foot narrow; tail short, pointed. A world-wide genus, its centre of distribution the Pacific slope.

The **Vancouver Macrocyclus** (*M. Vancouverensis*, Lea) has five whorls coiled like a watch spring, the spire scarcely elevated, the body whorl swollen and enlarged toward the aperture, which is diminished in size by the flattening of the wall above it. The epidermis is yellowish green; the interior of the shell, white. The pit is wide and deep. The lip is reddish yellow, sometimes reflected.

This is one of the large snails of the Pacific slope. It lives near the coast, except where it passes the Cascade Mountains into Idaho and Montana. At Astoria it reaches its highest development. Diameter, $1\frac{1}{4}$ inches.

Habitat.—Alaska to Lower California.

M. sportella, Gld., is not half the size of the preceding species, and much more delicate in structure. One requires a microscope to see the beauty of the sculpturing on its shiny, yellow-green surface. The sharp cross ridges are especially strong on the base of the shell. The pit is wide and shallow. The spire is a trifle elevated. Diameter, $\frac{1}{2}$ inch.

Habitat.—Puget Sound to San Diego.

M. Hemphilli, Binney, is glassy, thin, irregularly cross-ridged, with no sign of spiral sculpture. The pit is very narrow. Diameter, $\frac{1}{2}$ inch.

Habitat.—Oregon and Washington.

Circinaria is an allied genus.

CHAPTER LXIII: THE GLASSY SNAILS

FAMILY VITRINIDÆ

Genus **VITRINA**, Drap.

SHELL thin, glassy, of few whorls; animal too large to be withdrawn completely; tail short; mantle reflected over shell. Jaw and radula simple. Species about one hundred, terrestrial, living in moist situations in temperate or cold regions. These mollusks live in moist situations on earth or stones, sometimes crawling on snow. They are lively and jump when touched, and wrap themselves for protection in the folds of the mantle. They are herbivorous, but occasionally like the taste of flesh.

Pfeiffer's Glassy Snail (*V. Pfeifferi*, Newc.) looks like a slug wearing a glassy, greenish, three-whorled shell much too small to fit its body. The large, flaring lip is thin and plain. This snail lives in high altitudes in the western states. Diameter, $\frac{1}{8}$ inch.

FAMILY ZONITIDÆ

Shell a depressed spire, thin, transparent, with sharp, simple peristome; umbilicus present; animal able to withdraw into the shell. Foot with a mucus pore; jaw not ribbed; mantle lobed, but rarely reflected.

The glassy shells of these pitted snails, the presence of the mucus pore, and the thin, plain lip, set them apart from the Helicidæ. They inhabit dark, damp situations, have an onion odour and probably a taste disagreeable to birds. When first hatched they exhibit cannibal tendencies. A hungry specimen will eat a weaker brother, shell and all. They are numerous in Europe and America.

Genus **ZONITES**, Montf.

A European and American group, less showy in size and colouring than *Nanina*, and fewer in number of species. Epi-

dermis transparent. Diet vegetable. The genus centres in Italy and in the Danube basin.

Z. fuliginosus, Grif., is an olive brown, shiny snail, with an obliquely depressed, pitted spire and ample round mouth. Diameter, 1 inch.

Habitat.—Canada to Florida.

Z. cellarius, Müll., has immigrated from Europe to our country. Look for a small orb-snail with thin, glassy, pale blue shell with greenish yellow epidermis that shines. Its favourite resort is a damp cellar. It is a very active snail. Length, $\frac{1}{2}$ inch.

Habitat.—Pacific coast.

Z. arboreus, Say, inhabits bushes and hides in leaf mould. It is an orb shell, very small, amber, shiny, widely distributed, but hard to discover. It is easily mistaken for the young of other snails.

Habitat.—Many parts of North America.

Genus **NANINA**, Gray

Shell flattened or top-shape, with umbilical pit, and large mouth; outer lip simple, sharp; columellar lip reflected. Thicker shells than the others in the family, larger, less polished, banded and painted with gay colours. Shell partially covered by anterior mantle lobes. Glandular, posterior end of foot ends in a spine. Some shells reach three to four inches in diameter. Some are lens-shaped with a sharp keel; some are flat orb shells; others have elevated spires. Six hundred species, in tropics of the Old World. Terrestrial.

N. Cambojiensis, Rve., is a solid top shell, with wide left-handed aperture, a deep narrow pit, and rounded whorls cross-ribbed, and spirally banded with shades of brown. Diameter 3 inches.

Habitat.—Cambodia.

CHAPTER LXIV: THE LAND SNAILS. HELICES

FAMILY HELICIDÆ

SHELL a well developed spiral; lip smooth, or drawn in by a row of teeth: animal withdraws wholly into shell; jaw strong, usually orange-coloured, coarsely or finely ridged; central tooth of radula tricuspid; laterals, tricuspid or bicuspid; marginals usually wider than high, short, with two or three small cusps. Sexes united, but cross-fertilisation is necessary. A family of few genera and a multitude of species, all air breathers, and terrestrial, distributed all over the world.

The study given by conchologists to this great group of shells during the past few decades well illustrates the passing of the conchologist from the cabinet to the laboratory. I would better say back and forth between them. At first the shell alone was the basis of classification. But here is a variable family. Shells of the same species show very different coloration and markings. The study of the jaw became the basis for a new system of classification. But the jaw was found to be an unstable character. Shell and jaw alone lead to an artificial system of classification, and do not help to solve the problems of origin and relationship of species. Studies of the anatomy of the soft parts have thrown much light upon the subject.

The assembling of the species of *Helices* filled eight volumes of the "Manual of Conchology." In Volume IX. Pilsbry discards the older classification and declares for a new, natural system based upon the development of the shells and of several unrelated sets of internal organs. The genitalia and dentition are emphasised.

Under the new classification the *Helices* are reduced to about fifty genera. Of these the largest and most beautiful are tropical. The United States has representatives of several genera — our common land snails, dull in colour and of small size. The Philippines, Mauritius and the East and West Indian Islands have the showiest forms, the handsomest of which live in trees. Ground

snails are always dull-hued. One of the largest is a brindle-banded snail, *H. Falkneri*, Rve., four inches in diameter, from New Holland.

Genus *HELIX*, Linn.

Shell solid, globose or depressed; whorls about five, rounded or keeled; surface ribbed or granulated, plain, with spiral bands, usually five or fewer; lip expanded, reflexed or thickened. Mantle tough, granulose, grooved along back with side lappets, left long, right short. Sole undivided; tail depressed; jaw and radula well developed; reproductive system highly complex. Found in temperate and tropical countries.

In spite of the eliminations made by Mr. Pilsbry from Linnaeus's overburdened genus *Helix*, it still includes so large and so varied an assemblage of species that it is a hard matter to bound it. It is the most highly organised genus of snails. Naturally inhabiting wooded regions, yet these mollusks take kindly to life in the open, in striking contrast to our native snails which are largely destroyed with the laying waste of their forest homes.

Helix, lover of the sunshine, well deserves its name. Its cheerfulness under radical changes of climate and conditions of soil and food are a source of amazement to scientists. It is native to the mild regions around the Mediterranean Sea. North Africans, the people of Asia Minor, and of Southern Europe, all hold snails in high esteem as in article of diet, and have from the earliest times. In scattering to the western hemisphere these people have taken snails with them wherever they went; and these molluscan colonies have succeeded — in South America and North. The Roman soldiers probably took their favourite *Helix* with them when Cæsar invaded Britain in 56 B. C. So certain authorities hold, for colonies of *Helix* still exist near the sites of the old *castra*, built by Cæsar's soldiers.

The poorer classes in England consume snails in quantities each year. It is a common sight on the crowded thoroughfares to see a hungry person stop at a little charcoal pot and buy a penny's worth of hot boiled or roasted snails. These he picks out of their shells with a pin and eats them as he goes along. This is the brown-lipped woods snail (*H. nemoralis*), which White of Selbourne says is the favourite food of the song thrush. The

bird breaks the shell by repeated strokes upon a stone; particular stones are selected and resorted to regularly, as is proved by the heaps of broken shells around them.

The **Roman**, or **Apple Snail** (*H. Pomatia*, Linn.) of Europe stands preëminent among the multitude of species in *Helix*. It is typical of the whole genus, though in size and ornamentation the tropical species far excel it. Oriental and Latin races have brought it to this country, and successfully established it in various places, notably about New Orleans where the French cultivate it as a commercial shell fish. It is a common thing to see foreigners eagerly buying these plump snails by the quart on Saturday night at the heterogeneous push-cart and curb-stone markets that stretch away for many squares in the poorer sections of New York.

It is somewhat hard to resist buying these clean plump snails, they truly look inviting. They have a neatness of exterior not emulated by all of their kin. A creamy ground colour is decorated with three to five pale brown bands. There is a deep umbilical pit. The shell is globose or cone-shaped, of four or five rapidly widening whorls; the lip is thin, with reflexed edges; the columella long and concave. The foot is wide and fleshy, the mantle margin lobed; the head blunt with prominent stalked eyes. The average height and diameter are $1\frac{1}{2}$ to 2 inches. Yet we must expect a mollusk of such cosmopolitan distribution and such powers of adaptation to new conditions to exhibit great range of variation.

This snail has long been studied by conchologists, amateur and professional, and the reports of their investigations form a considerable body of literature. A great degree of intelligence is ascribed to it, including the homing instinct, which enables it to forage widely and return after each excursion to one "home" spot. Darwin reported that a pair of Roman snails, one of which was feeble, was placed in a small garden where food supply was scant. The stronger one set out alone, and found good pasture in the adjoining garden. The next day it returned and together the pair went over the wall where plenty abounded. The slimy trail of snails is probably their means of returning after a night's foraging by the same route that led them forth.

The senses of sight, smell and hearing are well developed. Snails kept as pets wander about curiously examining everything

they come to with their sensitive tentacles and stalked eyes. The prominent ribbed jaw, and the remarkably complex radula of twenty-one thousand teeth in serried ranks are freely exhibited in action by a hungry *Pomatia* to which is presented a crisp leaf of lettuce or cabbage.

The name "*Pomatia*" is not from the Latin *pomum*, an apple, though the shape has given significance to the familiar name, apple snail. The Greek *poma*, a pot lid, is the root word.

In autumn the snail prepares to go into winter quarters. It burrows down among grass roots and leaf-mould until comfortably pocketed, with the mouth upward; then it makes a roof of dead leaves and other rubbish cemented with slime. Now the body is drawn into the well hidden shell, and a thick limy stopper (the pot lid), called the epiphragm, is formed by the secretion of the foot gland. This has no single air hole, for it is porous, like plaster of paris. Now the snail draws its body still further back, makes an inner, papery door, and "lies down to pleasant dreams." In spring this period of hibernation ends, and a very hungry mollusk breaks through its doors, and comes forth to feast on the young shoots of growing things. In June the pea-sized, chalky-shelled eggs are laid in holes dug in the ground. The number of eggs varies; probably fifty is above the average. The young come out forty days after, eating for their first meal the egg shell that cramped their lusty growth at the last.

Fortunately this interesting snail breeds in captivity. In a snailery the whole life story may be watched. The simplest comforts suffice—a glass jar with floor of damp woods mould and a screened top to keep the snails in. A place outdoors in autumn insures the hibernating, which would not occur in a warm room. The growth of a flourishing snail brood is a wonderfully interesting serial story. Their food and water are easily provided.

Snail farming as a serious business thrives in the neighbourhood of large cities in France, for the French are great snail eaters. In all, nineteen species of *Helix* are considered edible, though the large "*Roman snail*," *H. pomatia*, is the most important, commercially. This species is rarely eaten in England, strange to say.

The modern French name, *escargatoire*, means "snail farm." Here is an authentic account of snail-raising for the Paris market, which consumes a hundred thousand a day on an average, the

largest consumption being reached during Lent. A Parisian takes fifteen or twenty snails for breakfast. These are usually boiled in their shells, and seasoned with fresh butter, mixed with parsley and a little garlic.

This farm was visited in 1896. It then had sixty to eighty thousand snails, all alike, except that some were slightly darker than others.

The farm consists of a large meadow fenced in from the road by boards a foot high. The owner employs people to collect snails from the neighbouring woods and meadows. They bring in from one to two thousand daily, commencing about April.

The snails are placed at once on one-half of the meadow and left to graze until July, when they are removed to the other half of the field. This is all divided up into squares like a gigantic chess-board by boards a foot high. Each square has a thick bed of moss on which the snails are placed, to be fed on cabbages for three months. They become very fat and large, and of a greenish colour, like the cabbage. Toward the end of September the snails begin to burrow down through the moss so that they are completely hidden. They lie there with the openings upward until they have completely closed themselves for the winter, forming a hard cover over the mouth of the shell. It is in this condition that they are exported, as they can now be kept till required.

The price the farmer gets for the sealed shells is seventeen francs (\$3.40) per thousand, and ten francs (\$2) for the open ones, which have to be used at once. All have to be dispatched to Troyes by the first of October, by which time all that were going to close will have done so. Some always remain open. From Troyes they are sent to Paris, where they come into season with the first frost.

The size of their snails was a matter of great pride to the Romans owning snail preserves, called *cochlearia*. Meal and new wine fattened them for market. On this diet, the snails of Hirpinus reached such size that a single shell held eighty-six penny pieces. Varro recommended that a ditch be dug around the snaileries to save the expense of a special slave to catch the runaways which scaled the walls.

Pliny the Younger reproaches his friend Septicius Clarus for breaking a dinner engagement with him, at which the menu was to have been a lettuce, three snails and two eggs apiece, barley water, mead and snow, olives, beet roots, gourds and truffles, and going off somewhere else where he got oysters, scallops and sea urchins.—*Cooke*.

The **European Spotted Snail** (*H. aspersa*, Müll.) is a dingy, vagabondish mollusk, hated by gardeners, whose choicest and tenderest plants it attacks by night in garden or greenhouse. The five-whorled shell is brownish yellow, with five dark brown bands made of spots, and a thick, white, recurved lip. The average shell is somewhat over an inch in diameter.

Blackbirds, thrushes and glow-worms conspire with man to exterminate this mollusk, but they merely check its ravages. Though eaten in England it is not a choice species. In America it is one of the most prosperous and best-hated of immigrant mollusks, as its appetite for vegetables and flowers is insatiable. I remember with what vindictive heel my neighbour in southern California crushed these destroyers of his nursery stock.

In the snailery a brood of these snails may be raised, and every step in the life history of each robust youngster watched from the egg. Vegetable food, such as lettuce and cabbage, should be growing for them, and their habits carefully observed. Nothing is more entertaining and instructive than this study. Two years brings the snail to maturity.

"Left-handed," or sinistral specimens of this species are worth looking for. They occur occasionally, and are greatly prized by collectors. There are plenty of enthusiasts ready to pay a guinea (\$5) for every perfect adult shell.

If one keeps the subject in mind, and drops an inquiry here and there, he will gather quite a fund of curious information about the uses of snails from country folk of the old-fashioned sort who hoard traditions carefully. A walking trip through England will be especially productive, for that humid climate has always been favourable for these mollusks. If you chance to look pale and thin you will be told that a diet of live snails or slugs will cure consumption. It will also build up the constitutions of anæmic persons and sickly children. Snails are prescribed by local physicians for a number of complaints, including asthma, dropsy, eye troubles, rheumatism and corns. Among recipes copied by Lovell from old books, I find the following:

Snails which bee in shell beat together with bay salt and mallows, and laid to the bottomes of your feet and to the wristes of your handes, before the fit cometh, appeaseth the ague.

Slime of slugs and snails was counted a sure cure for eczema. Credit is still given to this remedy by intelligent people. A

naturalist writing to the *Journal of Conchology* mentions that when working in his garden toward evening he is often bitten by midges. These bites swell and burn afterward, unless he picks up a snail and lets it crawl over the part bitten. After this treatment all signs of the bites disappear.

Whistles and other toys, necklaces and bracelets made of snail shells are sold to tourists all over Europe. *H. nemoralis* and *H. acuta* are the species commonly used for stringing.

Snails are the accepted barometers of the common people. If they leave the herbage and take to the bare rocks, or if they climb trees you may expect rain.

Dishonest dairymen manufacture "cream" out of skim milk by squeezing into it the clear mucus of snails. The consistence of the milk becomes creamy, and a little annatto gives the yellow colour. This is a very ancient practice, but still in favour in parts of England.

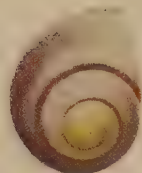
The most beautiful of the Helices are the numerous species of the Philippine genus *Cochlostyla*. Hugh Cuming was the fortunate conchologist who discovered these wonderful land and tree snails, gay as the birds and insects of those tropical islands. Instead of rashly plunging into unknown tracts of forest jungle, Cuming hired the natives to bring him all the snails they could find. There was no danger, he knew, of an over supply, for to the cabinets of European collectors these shells would soon be distributed when he was ready to make known the treasure he had uncovered in this far country. Children entered the race, discovering many species their fathers overlooked. By tactful explanations, and by curing some minor ailments by his knowledge of medicine, Cuming established himself in the good graces of the population, and thus was able to carry back to England all he wanted (if that could ever be) of nearly two hundred species. Imagine his feelings when one day he went out to meet one of his native collectors who stalked along under the burden of a large bag filled with specimens. Splendid *Cochlostylæ*, at that time absolutely unknown to the scientific world, were crawling down the man's back and escaping to the woods.



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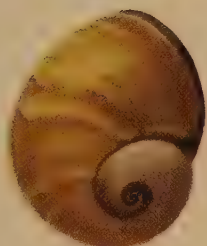
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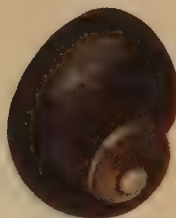
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TROPICAL LAND SHELLS

35 Little Top Shell, *Trochatella Tankervillei*, Gray.36 Helicina, *Helicina Sagraina*, d'Orb.37 Queen Top Shell, *Trochatella regina*, Morl.38 Banded Snail, *Orthalicus Deburghia*, Rve.39 Banded Helix, *Helix (Cochlostyla) Portei*, Pfr.40-47 Painted Helix, *Helix (Polymila) picta*, Born. (showing variations).

CHAPTER LXV: NORTH AMERICAN LAND SNAILS

NORTH AMERICAN genera of the Helices may be grouped by peculiarities of the lip of the shell into four classes. Certain notable exotic genera will be mentioned with natives in their proper class under this simple key, made by Dr. Pilsbry for beginners.

- A. Shell with thin, sharp lip, not expanded:
 - Genus Pyramidula
 - Genus Glyptostoma
- B. Shell with blunt, thick lip, not expanded:
 - Genus Polygyrella
- C. Shell with lip expanded, not flatly reflexed:
 - Genus Epiphragmophora
 - Genus Vallonia
- D. Shell with lip decidedly reflexed, often toothed:
 - Genus Polygyra.

THE PYRAMID SNAILS

Genus PYRAMIDULA, Fitz. (PATULA of recent authors)

Shell cone-shaped to flat disk-shaped, with open umbilicus; opaque, one-coloured, banded or flame-streaked; whorls rounded or keeled; aperture rounded; lip thin, simple. Foot undivided, lateral margin with a border set off by a groove. No mucus foot pore; eye peduncles long and slender.

Dull coloured, ground-living snails, found all over northern temperate land areas.

The type, *P. ruspestris*, Drap., is a neat, low-coned, brown snail with rounded coils and a deep pit. Diameter, $\frac{1}{2}$ inch.

Habitat.—Central and Southern Europe.

The **Perspective Pyramid** (*P. perspectiva*, Say) shows a

widening pit separating its flattened coils. The reddish streaked, horny shell is finely striated. Animal has narrow white foot; head dusky, blue, granulated; eye-stalks slender. Diameter, $\frac{3}{4}$ inch.

Habitat.—Northern United States.

Sub-Genus **PATULA**, Held

Shell depressed, top-shaped, with a deep, conical umbilicus; foot large. A sub-genus of several hundred species; of universal distribution.

In the eastern states these snails lay eggs; the western species bring forth young alive, probably because of the aridity of the climate; eggs laid in the ground would not hatch, owing to drought.

P. alternata in the East and *P. strigosa* in the Rocky Mountain region, are among our commonest land snails.

The **Alternate Patula** (*P. alternata*, Say) is decorated with interrupted streaks of reddish brown, that often zigzag across the whorls. The shells are thin and transparent, sculptured with close diagonal raised striæ. Lip smooth. Found in colonies on decaying logs or in other damp places in woods, or even in city backyards. In winter they are found in pockets. Binney believes this crowding together is for the purpose of preserving bodily warmth. Diameter, 1 inch.

Habitat.—Eastern and central United States.

In *P. solitaria*, Jay, the large body whorl is banded with three brown lines. It has a deep narrow pit, and a somewhat elevated apex. Habit, solitary. Diameter, $1\frac{1}{2}$ inches.

Habitat.—Central and northwestern states.

The **Streaked or Mountain Snail** (*P. strigosa*, Gld.) is streaked by two brown bands that encircle the body whorl, the upper one of which winds almost to the apex. In contrast to the translucent flesh tint, a band of opaque white separates the two brown ones. The best place to look for specimens is at the foot of crumbling limestone cliffs.

This is the commonest snail between the Rockies and the Sierra Nevada. In Utah and Idaho it is especially abundant. Varieties reach the altitude of 8,500 feet. Naturally the species is variable. Diameter, under 1 inch.

Habitat.—Rocky Mountains, western slopes.

P. Cumberlandiana, Lea, has the open pit and the flattened spire of this sub-genus. It reminds us of the marine genus *Solarium*, the sun-dial shells. Finely cut, erect ridges diagonally cross its whorls. A thin-edged keel divides the body whorl into an upper and a lower half, and notches the outer lip. The markings of brown are like those of *H. alternata*. Diameter, $\frac{3}{4}$ inch.

Habitat.—Cumberland Mountains, Tennessee.

Genus GLYPTOSTOMA, Bland and Binney

Shell discoidal, with slightly elevated spire; whorls rounded, six; lip thin, simple; umbilicus broad, showing all the coils plainly; colour black or reddish brown; parietal wall of aperture beautifully sculptured. Animal bluish slaty.

The single species known, **G. Newberryanum**, Binney, is a large snail very common on rocky hill slopes about San Diego, Cal. In summer it hibernates, with its aperture closed. The characteristic spiral sculpture of the parietal wall of the aperture becomes overlaid by a white callus as the shell matures. So the trait upon which the generic name is based is seen only in immature specimens. Diameter, 1 to 2 inches.

Habitat.—Southern California.

Genus POLYMITA, Beck

Shell flattened, globular, brilliantly coloured, solid though thin, whorls three to five; axis solid, outer lip not expanded; animal black above, slaty below.

The **Painted Snail** (*P. picta*, Born.), one of the most gaily dressed of land snails, lives in trees. Individuals are quite different in colouring; this accounts for the large number of named varieties. The ground colour has its beauty heightened by narrow stripes of darker, contrasting colours, that outline the sutures and the outer lip. There are yellow shells ornamented with a scarlet spiral thread; chestnut brown with white bands; dark blue with white-edged black bands, and salmon red, similarly trimmed. The large, half-moon shaped aperture shows a violet or white interior. The simple lip is thickened within.

What a sight to see these gay little mollusks slipping about

North American Land Snails

among the tree branches which are their homes! They harmonise with the brilliant tropical vegetation. Diameter, 1 inch.

Habitat.—Cuba.

Genus **SAGDA**, Beck

The **Tied Helix** (*H. alligans*, Ads.), is thimble-shaped, with a concave, depressed base and blunt apex. Whorls eight to ten, flattened, the last one faintly keeled. The lines of growth show as faint, diagonal striæ. The white shells are invested with a yellowish horny epidermis. The aperture is semi-lunar; lip thin, sharp. Umbilicus wanting. Height and width, 1 inch.

Habitat.—Jamaica.

Genus **POLYGYRELLA**, Binney

Shell a flat spiral, with wide umbilicus; coils seven to eight, cross-ribbed above; glassy, shining, yellowish, horn-colour; lip not expanded, thickened at edge by white rim, and armed with two or three teeth; columella bears triangular tooth.

The single species, *P. polygyrella*, Bland and Cooper, $\frac{1}{2}$ inch in diameter, lives in the spruce forests of the Cœur d'Alène Mountains in Idaho.

Genus **PLEURODONTÉ**, Fisch. (**CAROCOLUS**, Montf.)

Shell large, solid, more or less flattened; whorls four to six, rounded or keeled; lip flaring or reflexed, generally toothed. Eggs large, oval, hard-shelled; foot undivided, sides granular; mantle edge frilled.

A tropical American genus of large ground snails whose nearest relatives inhabit China, the East Indies and Australia. The genus exhibits a great variety of forms.

The **Wavy Pleurodonte** (*P. sinuata*, Müll.) has its doorway narrow and guarded by white teeth or wide and smooth-rimmed. The variation in form is from a top-shaped cone to a lens with keeled rim. There is also a wide-mouthed nerite form. Brown banded with yellow, white, wound with yellow, and unbanded shells, from chocolate to cream, indicate the range

of colour. The young have shells of two and one-half whorls before hatching. Diameter, 1 to 2 inches.

Habitat.—Jamaica.

P. gigantea, Scop., is thick, brown, obliquely streaked, with a white lip thickened and expanded. Diameter, 2 to 2½ inches.

Habitat.—Haiti.

P. jamaicensis, Chemn., has the nerite form, bright chestnut with pale bands, and a very thick, broad, white rim overlying the columella and outer lip. Diameter, 2 inches.

Habitat.—Jamaica.

Genus CEPOLIS, Montf.

Shell depressed, globular, smooth, umbilicate or not; lip reflexed at columella, usually thickened with callus, sometimes toothed, one-coloured or conspicuously banded; jaw high, arched; radula long.

C. cepa, Müll., has a finger-like fold of callus within the mouth, and another on the anterior margin bearing a tooth. The pale chestnut ground is banded above by spiral lines of brown. This ground snail, 1 to 1½ inches in diameter, is quite dull beside the arboreal species, which are gaily coloured in both body and shell.

Habitat.—West Indies.

Genus LYSINOË, H. and A. Ads.

Shell depressed, globose, granulated or hairy; brown with spiral bands; aperture lunate; lips somewhat reflexed; body very large, coarsely granular above, tail keeled. Three species.

L. Humboldtiana, Fér., with an elevated spire and three dark bands, is a Texan species. Diameter, 1 to 2 inches. The type, however, of the genus is the larger, more flattened *L. Ghiesbreghtii*, Nyst., with more elaborate banding—a symphony in brown—which inhabits Central America.

Genus EPIPHRAGMOPHORA, Doring (AGLAIA and ARIONTA of American authors)

Shell discoidal to globose, four to seven whorls, rarely keeled; horny to chalky; variegated and banded; lip thin, expanded or

North American Land Snails

reflexed, epiphragm secreted by certain species, but not a constant character. A large genus distributed on the Pacific slopes of America.

The **Faithful Snail** (*E. fidelis*, Gray) has a low cone with rounded, smooth whorls banded with brown. Basal area of body whorl dark brown to black. The umbilicus is open, but contracted at the top by the flaring of the lip. Epidermis yellowish. Diameter, 1 to 1½ inches. Late broods are often found tucked away in holes in the trunks of maple trees, far above the ground.

Habitat.—Vancouver Island to California.

E. Mormomum, Pfr., has a more flattened spire. The thin body whorl, pale reddish, with arching striæ, is adorned by a chestnut band, doubly edged with white. The aperture is ear-shaped and oblique, its rim white and recurved. Diameter, 1 inch; height, ½ inch.

Habitat.—Mountains of California.

The **Point Cypress Snail** (*E. Dupetitboursi*, Desh.) is low-spined, its seven brown whorls decorated with a yellow-edged, almost black median band. The body is grayish, and warty. Diameter, ¾ inch.

Professor Keep found these snails asleep in debris under the gnarled old veteran cypresses of Monterey. They were dormant in the drought of summer, and many shells were empty, punctured by hungry jays. The living ones became quite active when put into a damp fernery, and sprinkled with water.

E. sequoicola, Coop., which lives among the red-woods near Santa Cruz, has a more elevated spire, roughened by fine ridges, and granulated about the apex.

E. Traskii, Newc., and **E. Carpenteri**, Newc., each wears a band of brown, edged with yellow or white, on a horn-coloured, striated surface. The latter is more delicately built throughout. Diameter, less than 1 inch.

Habitat.—Southern California.

E. Coloradoensis, Strns., is low-spined, fragile and pale, with a narrow red band. The mouth is large. It was found at a high elevation near the Grand Cañon of the Colorado. Diameter, ¾ inch.

The **Dented Snail** (*E. arrosa*, Gld.) has a more solid and elevated spire than the preceding species, with a dark band on the yellowish brown coils. The rough surface has furrows of different

lengths. The pit is not covered by the reflected inner lip. Diameter, $1\frac{1}{4}$ inches.

Habitat.—Central California coast.

E. Californiensis, Lea, is nearly globular, thin and banded. It lives in sandy localities near the ocean, burying itself in summer under clumps of rattleweed. There are numerous varieties. Diameter and height, 1 inch.

Habitat.—Monterey.

E. tudiculata, Binney, olive brown, with a wide, dark band in a zone of paler hue, has a rough, indented surface, though the shell is thin. The lip is white and thickened near the pit. Diameter, 1 inch.

Habitat.—Central and Southern California.

The **Brown-banded Snail** (*E. rufocincta*, Newc.), with a narrow girdle, is a low-spined, thin, smooth shell, $\frac{3}{4}$ inch in diameter.

Habitat.—Santa Catalina Island.

Several other western species are described by Professor Keep.

Genus VALLONIA, Risso

Shell minute, discoid, of three to four whorls; umbilicus wide open; aperture roundish, with flaring white rim, nearly circular.

V. pulchella, Müll., deserves mention here because it covers the northern hemisphere, and has colonised some regions south of the equator. It is found in companies, living under bark of trees, fragments of rock, or on the moss of bogs, always away from the light. Its transparency and its minute size make for protection; it is only $\frac{1}{8}$ inch across. No wonder it lives its life with little molestation. It frequently appears suddenly and in great numbers in places where it was unknown before. In this way, Dr. Stearns found it in his yard in Los Angeles. It is also reported from Utah and other western states.

Ashmunella rhyssa, Dall., is a low-spined, pitted snail, finely cross-wrinkled, with a white lip that flares, but is constricted just inside the aperture, which has a thickened tooth on its inner wall. Diameter, $\frac{3}{8}$ inch.

Habitat.—Mountains of New Mexico.

A. Levettei, Bld., is a thin, shining, transparent, orb-snail,

of seven whorls, with teeth on both outer and inner lips. Diameter $\frac{1}{2}$ to $\frac{3}{4}$ of an inch. Sante Fe, N. M.

THE WHITE-LIPPED SNAILS

Genus POLYGYRA, Say

Shell many-whorled, globose to flat-coiled, keeled or rounded, plain or banded; aperture plain or obstructed by three teeth; lips reflexed; foot long, narrow, granulated.

A large genus including *Triodopsis* and *Mesodon* of Rafinesque. Its distribution centres in eastern North America, but there are several western species.

The **White-lipped Snail** (*P. albolabris*, Say), familiar to many under the old name, *Helix*, or the newer one, *Triodopsis*, or by any other, in fact, is still the same old horny yellow, white-lipped snail, known by all woods rovers with an eye for the small people who live under dead leaves and under prostrate, decaying logs. The spire is slightly elevated above the large, fifth whorl, whose rim is the thick, flanged white lip. Excess of white enamel fills the central pit, and a nodule of it forms a tooth on the inner lip. The only sculpture on the outside is the growth striation.

The long, slender, mottled body, the four "horns," the longest bearing the black eyes, the graceful movements and the "moon-glittering trail"—all are sources of wonder and delight to children of all ages. Yet how many foolish grown-ups have inherited or acquired the aversion credited to the four-and-twenty tailors! Diameter, 1 inch. Eastern states.

P. Townsendiana, Lea, a handsome pitted snail, is yellowish brown, often mottled, and finely striated, with a thickened white peristome, shaped like a horseshoe, and no teeth to be seen. Diameter, $\frac{4}{5}$ inch. Oregon and Washington.

P. devia, Gld., solid, six-whorled, brownish, low-spined, has a white lip, bent outward, and a tooth on the inner wall of the aperture. Several varieties occur in Oregon and Idaho. Diameter, $\frac{1}{2}$ to 1 inch.

P. Chiricahuana, Dall, is a thin, glossy brown orb-shell, deeply pitted, with a simple, toothless aperture, and a white strongly reflected lip. It is $\frac{3}{4}$ inch across.

Habitat.—Arizona and New Mexico.

CHAPTER LXVI: THE HUNGRY SNAILS

FAMILY HELICIDÆ

Genus **BULIMUS**, Scop.

SHELL spiral, ovate-oblong, solid, whorls few, the last one ventricose and large; aperture elongated; columella wide; lip thick, turned back. Animal like *Helix*; jaw simple, ribbed. Tropical America.

The **Ovate Bulimus** (*B. ovatus*, Müll.) attains the length of six inches, and except *Achatina*, is the largest known land snail. The Negroes of Rio Janeiro buy it as a shell fish in the markets, and consider it a delicacy. The eggs are white and hard-shelled, and so large that one might easily mistake them for pigeons' eggs. The mollusk lays them (not many) in a rude nest dug in the ground and loosely covered with dead leaves. The eggs, too, are used as food.

The shell is ovate, with prolonged spire, and has the nondescript, streaked, horny colour calculated to conceal it from detection among dead grass blades.

Habitat.— Forests of Brazil.

Many smaller species are brightly painted, and have curiously exaggerated lip expansions, inside and out.

Sub-Genus **STROPHOCHEILUS**, Spix

The thick-lipped **S. scarabus**, Alb., has a pointed ovate spire, with brown epidermis covering the white shell substance. The peristome is simple, surrounding the ear-shaped or oval aperture. The largest specimens are four to five inches long, and come from New Caledonia.

There are African and Brazilian species.

Genus **BULIMULUS**, Leach

Shell oblong, aperture longitudinal, lip thin. About six hundred species. Tropical America. Several Mexican species invade Texas and other Southern states.

B. multilineatus, Say, with its seven yellow whorls wound with varying bands of brown, ranges from New Granada to the coasts of Florida. Length, 1 inch.

B. alternatus, has irregular pale brown and drab longitudinal bands traversing its spire. The white lip has a tooth folded back over the columella. This Mexican species is abundant on bushes in Texas. Dead shells often cover the ground beneath. Length, $1\frac{1}{2}$ inches.

Buliminus, Ehrenb., is a large Old World genus corresponding to the New World *Bulimulus*.

Mr. Layard, an English field naturalist, who explored the Comoro Islands, west of Africa, in 1854, writes:

One day I took refuge from a shower of rain under a bushy tree creeper. I observed that the branches were covered with short, stout spines. As the rain ran down the branches I was astonished to see some of the "spines" move along the bark! On taking them in my hand I was pleased to find that they were *Bulimini*! They were covered with a thick, scurvy epidermis exactly like the spines of the creeper.

Here is a fine instance of protective mimicry.

Genus **BINNEYA**, Coop.

Animal slug-like, blunt before, tapering behind; shell central, of few coils, ear-shaped, covering the mantle, but not the body; jaw and radula prominent. The shell contains the coiled visceral parts. The foot is free and unprotected by the shell.

B. notabilis, Coop., a Mexican species, wears its tiny, ear-shaped, horny shell as a collegiate youth does his "ingrowing" cap. In the hot summer this slug-like mollusk clothes its soft body in a papery chrysalis attached to the shell. Length, $\frac{1}{4}$ to $\frac{1}{2}$ inch.

Habitat.—Santa Barbara Islands.

CHAPTER LXVII: THE BANDED SNAILS

FAMILY ORTHALICIDÆ

SHELL as in *Bulimus*, thin, without a pit; lip thin, simple; columella straight; jaw pointed in front, with oblique shingling side plates. Radula of fine cusped teeth in V-shaped rows. A family of tree snails that secrete a thick, dry epiphragm and hibernate during the dry season.

Habitat.—Tropical America.

Genus ORTHALICUS, Beck

Characters of the family.

The **Waved Orthalicus** (*O. undata*, Brug.) is strikingly, but irregularly, banded both ways with chocolate on a pale ground. It grows noticeably larger on the mainland than on adjacent islands. Length, 2 inches.

Habitat.—Central America.

O. zebra, Müll., is distinguished from its close relative by chestnut zigzag lines of more distinct pattern.

The tropical summer is the period of "æstivation" for land mollusks; they become inactive, burying themselves deeply in the ground or attaching themselves to the under sides of rocks, or to tree trunks, or stalks of grass. The beautifully painted *Orthalicus* of South America disappears underground for this season. When the rains come they joyfully climb to the highest treetops. Tropical countries that throng with land mollusks in the rainy season, seem quite as barren of life in midsummer as colder regions do in midwinter, when mollusks are hibernating.

Sub-Genus LIGUUS

Under this division is assembled a group of species and varieties with shells so graceful and beautiful that they charm everyone. The shapely, slender spire is wound with narrow

The Banded Snails

stripes, distinct, various and harmonious in colour. There are often broad wavy bands crossing the whorls.

The **Stripped Liguus** (*O. fasciata*, Müll.) is sometimes pure white. Many are decorated only with pale green, spiral, pin-stripes. Here is a white one wound with pink, lavender, olive, yellow and black, arranged in a striking system of lines of varying widths. Soft tints, hard to define, such as one sees in Japanese prints, abound on the polished coils of these delicate shells. Few tropical sea shells are half so attractive. To see them carried on the backs of tree snails along the limbs and among the leaves and flowers of tropical plants is worth a journey around the world.

In winter they hibernate by attaching their apertures strongly to the bark of the tree, by means of a viscid, opaque substance like glue. In tearing off a specimen, the bark or the shell will give way before this cement does. Sometimes the individual retires into its shell and secretes a thin, pearly door as a protection. In this comatose state many are devoured by tree crabs. The slenderer, *O. virginica*, Montf., of Haiti, shares with its gay companions the danger of being seized by the bloodthirsty *Glandina* if it chances to drop to the ground. Length, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.— West Indies and Florida.

CHAPTER LXVIII: THE AGATE SHELLS

FAMILY ACHATINIDÆ

SHELL thick, ovate, with elongated spire, and ventricose body whorl; aperture oval, large, sometimes on the left side; columella twisted, arched; lips united by a shiny callus.

Some agate shells are larger even than the great Brazilian snails, *Bulimus*. They, too, lay white eggs, over an inch long. In truth the *Achatinæ* in Africa are parallel in characters, as in latitude, with the *Bulimi* in South America. But the agates are tree snails, and so dare to be gaily marked, while *Bulimus*, the ground snail, must be dull.

Genus ACHATINA, Lam.

Shell oblong-oval; spire conical; aperture oval; whorls rounded, six to nine, sometimes sinistral; lips united by a shiny callus. About seventy-five species, living in trees. Tropical Africa.

A. variegata, Lam., dull tan-coloured with broad streaks of dark brown running full length of the shell, is one of the largest species. Length, 6 to 8 inches. West Africa.

The **Zebra Agate Shell** (*A. zebra*, Lam.) is streaked with zigzag longitudinal lines of chestnut on a white ground. The shell is ovate. Length, 4 to 5 inches. Madagascar.

A. sinistrorsa, Chemn., one of the largest agates, coils to the left. It has a lurid brownish body whorl, with bright, chestnut-streaked spire. Length, 4 to 5 inches. Isle Principe, Africa.

A. reticulata, Pfr., has a slender, creamy white spire of gracefully rounded coils, finely streaked and dotted with chestnut. The shiny surface is raised in fine rounded ridges crossed by close spiral grooves. Length, 6 to 8 inches. Africa.

A. purpura, Chemn., horny outside, has a rosy lining. Length, 3 to 5 inches. West Africa.

The **Panther Agate Shell** (*A. panthera*, Pfr.), striped and tawny like its namesake, lives in hollows in the rocks and in trees,

The Agate Shells

where it is protected from the sun. On the mainland it grows larger than on the islands and the shell is thicker. The mollusk is omnivorous, eating when kept in captivity, meat, vegetables, dead snails — even pieces of old newspaper. One laid, in a snailery, two hundred small eggs.

The dry season drives them all into holes in rocks and trees. They often congregate, a dozen or more in one pocket. The shell is sealed with an opaque, papery epiphragm. Length, 2 to 4 inches. Mozambique and African coast.

Genus **STENOGYRA**, Shuttl.

Shell long, turreted, white or transparent; whorls many, delicate; aperture oval; lip simple, sharp. Two hundred and fifty species in tropical and temperate countries.

The **Obelisk Stenogyra** (*S. obeliscus*, Moric.), is a handsome, yellowish, auger-shaped shell, the last whorl about one-quarter the total length. Length, 3 to 4 inches. Width, $\frac{3}{4}$ inch.

Habitat.—Tropical America, Natal, Philippines.

The **Limy Stenogyra** (*S. calcarea*, Born.) shows its calcareous substance by the scaling off of the chestnut brown epidermis. But little longer than *S. obeliscus*, it is much larger, its basal diameter is sometimes $1\frac{1}{2}$ inches. Brazil.

S. decollatus, Linn., smooth, delicate, of pale livid hue, well illustrates the peculiar habit of building partition walls, and then dropping off the shell apex, by degrees. Moquin-Tandon reports that the mollusk jerks the shell against some hard object to break it off. The average specimen has four or five whorls remaining. This European species is established at Charleston, S. C. Length, 1 to $1\frac{1}{2}$ inches.

THE LITTLE AGATE SHELLS

FAMILY ACHATINELLIDÆ

Shell small, conical, dextral or sinistral, solid; columella plaited, lip thickened within the aperture.

Genus **ACHATINELLA**, Swains.

Shell smooth, whorls six or seven, banded and spotted with bright colours; columella short, callous, or toothed, often twisted;

aperture small. A very large genus confined to the Hawaiian Islands. They live upon trees and bushes from the central watershed of each island down to sea level. Each isolated mountain valley has its own peculiar species. Among them are some of the most gaily painted shells known. A calamity fell upon the whole genus (and upon conchologists) when cattle were introduced into the Islands. The cropping of foliage by goats has destroyed vast tracts of undergrowth where the *Achatinellæ* lived. Grazing herds of larger cattle are stripping the wooded regions. Many species have already disappeared.

The collector is always in an ecstatic mood when he is finding plenty of the specimens he seeks. If they are beauties, the greater is his joy. A writer to the *Quarterly Journal of Conchology* had an added thrill.

When up the mountains of Oahu I heard the grandest but wildest music, as from hundred of Æolian harps, wafted to me on the breezes, and my companion, a native, told me it came from the singing shells, as he called them. It was sublime. I could not believe it, but a tree close at hand proved it. On it were many of the *Achatinellæ*, the animals drawing after them their shells, which grated against the wood and so caused the sound; the multitude of sounds produced the fanciful music. From this one tree I took seventy shells of all varieties.

The **Beautiful Agate Shell** (*A. pulcherrima*, Swains.) has a conical shell, blunt at the apex, its shining olive-green surface decorated with spiral bands of brown. Some have only a stripe in the suture. Others have several bands of varying widths. Length, 1 inch.

Habitat.—Oahu.

The **Rosy Agate Shell** (*A. rosea*, Swains.) is white tinged with pink which gradually is intensified till it becomes a bright rosy rim inside the lip. Length, $\frac{3}{4}$ inch.

The **Partridge Agate** (*A. perdix*, Rve.) is a warm chestnut streaked across the whorls with white so as to imitate the pattern of the plumage of a partridge. Length, 1 inch.

Habitat.—Maui.

The **Splendid Agate** (*A. splendida*, Newc.) is wound with close lines of white and brownish yellow, of various widths. The mouth is large and oval, apex sharp, whorls rounded, suture deep. Length, 1 inch.

Habitat.—Maui.

The Agate Shells

The **Bloody Agate** (*A. sanguinea*, Newc.) has a pointed spire of flattened whorls. The ground colour of dark red is crossed by an irregular system of zigzag streaks of black. Length, $\frac{3}{4}$ inch.

Habitat.—Lehiu, Oahu.

Genus CARELIA, H. and A. Ads.

Shell long, turriculated, with flattened whorls; columella strongly arched and twisted; aperture small. Few species in Hawaiian Islands.

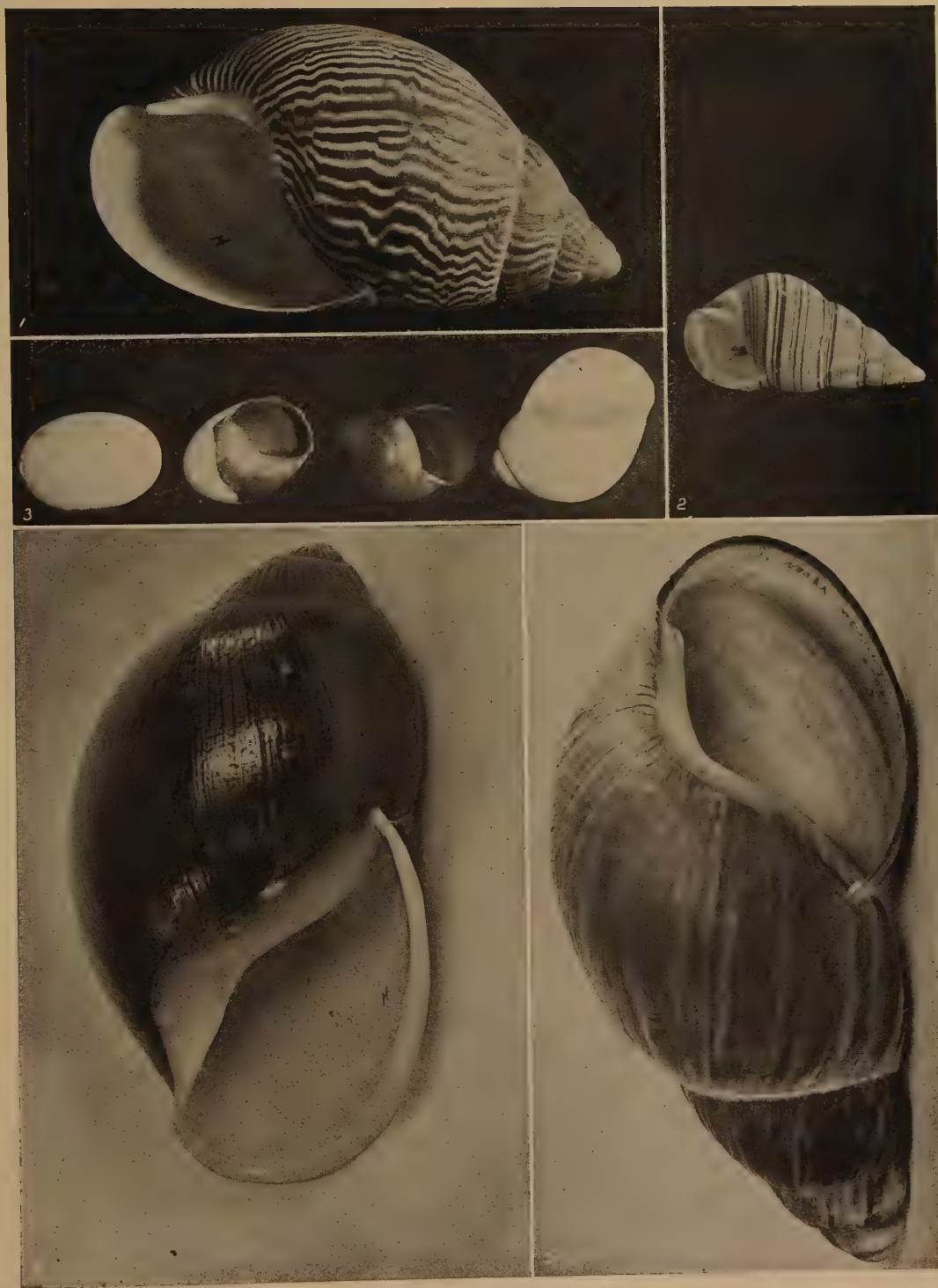
The shells of this genus are larger than in Achatinella. They show a prevailing preference for shades of brown.

The **Obelisk Carelia** (*C. obeliscus*, Rve.) is three times as high as its width at base. There is a sharp median angle on the body whorl. Dark brown at base, the colour gradually fades toward the blunt apex. Length, 3 inches.

Habitat.—Hawaii.

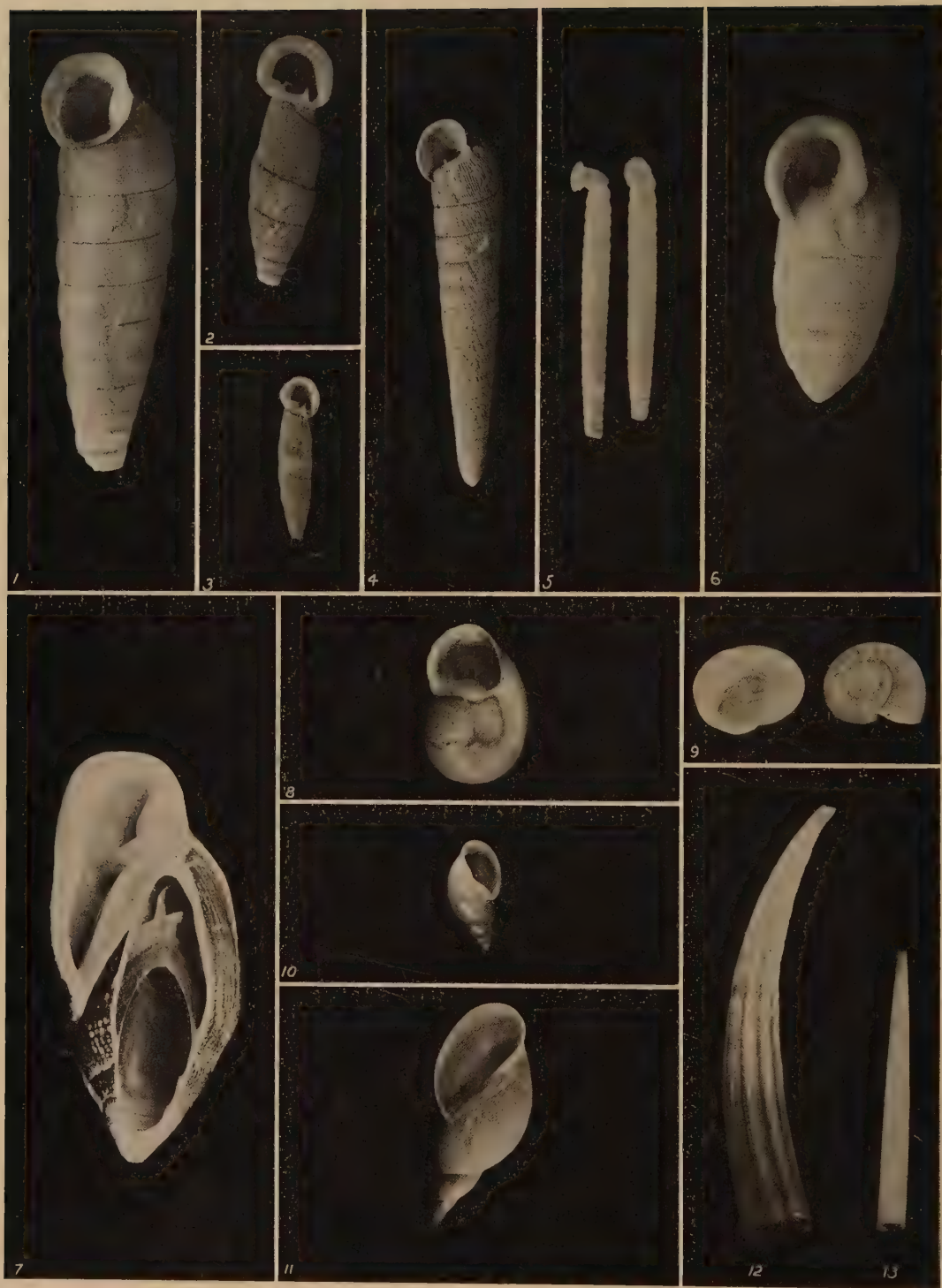
Cuming's **Carelia** (*D. Cumingiana*, Pfr.) is the handsomest species. Each flattened whorl is bevelled at both margins as if by an edged tool, making the suture a regular channel, which is outlined with white spiral lines. The browns in the elongated spire emulate the shading in a middle-aged meerschaum pipe. Length, 2 inches.

Habitat.—Kauai.



TROPICAL SNAILS

- 1 Zebra Agate Shell, *Achatina zebra*.
- 2 Banded Tree Snail, *Liguus fasciata*.
- 3 Brazilian Hungry Snail, *Bulimus ovatus*, hatching from eggs.
- 4 Brazilian Hungry Snail, *Bulimus ovatus*, adult shell.
- 5 Left-handed Agate Shell, *Achatina sinistrarsa*.



CYLINDER SHELLS, POND SNAILS, MIDAS' EAR AND TOOTH SHELLS

- | | | | |
|------------------------------------|--------------------------------------|-------------------------------|-----------------------------------|
| 1 <i>Cylindrella Gheisbrechii.</i> | 4 <i>Megaspira elatior.</i> | 7 <i>Auricula auris-Mide.</i> | 11 <i>Limnaea stagnalis.</i> |
| 2 <i>Clausilia tridens.</i> | 5 <i>Cylindrella Agnesiana.</i> | 8 <i>Planorbis trivolvis.</i> | 12 <i>Dentalium elephantinum.</i> |
| 3 <i>Clausilia Ardoniniana.</i> | 6 <i>Strophia (Cerion) decumana.</i> | 9 <i>Circinaria concava.</i> | 13 <i>Dentalium pretiosum.</i> |
| | | 10 <i>Physa gyrina.</i> | |

CHAPTER LXIX: THE CYLINDER SHELLS

FAMILY CYLINDRELLIDÆ

Shell screw-like, turreted, many-whorled; the last whorl more or less contracted and detached; peristome reflected, prolonged, apex often cut off. Animal like *Helix*.

Genus **CYLINDRELLA**, Pfr. :

Characters of the family. Many species of small mollusks, of sluggish movements. West Indies.

C. jejuna, Gld., is a small, solid, horn-coloured shell striped lengthwise with fine white lines. Its tip is truncated, the free round mouth protrudes in the form of a bell. Length, $\frac{3}{4}$ inch.

Habitat.—Mouth of Miami River, Fla.

C. Poeyana, d'Orb., is stouter, pupiform, longitudinally striated and white-lined. The animal walks by affixing the extended snout and dragging the body up to the point. The shell is carried in a horizontal position. The body is about one-quarter as long as the shell. Length, $\frac{3}{4}$ inch.

Habitat.—Cuba, Southern Florida.

Several West Indian species are slim as a match, a tightly coiled spiral, with the little free cup-shaped peristome at right angles with the spire. *C. Blandianum*, Cr. and Fisch., and *C. Ghiesbreghti*, Pfr., both Mexican, suggest by their form, size and colouring a half-smoked cigar.

CHAPTER LXX: THE CHRYSALIS SHELLS AND DOOR SHELLS

FAMILY PUPILLIDÆ (PUPIDÆ)

SHELL cylindrical, many-whorled, usually minute, with contracted aperture, guarded by teeth, often set with internal lamellæ; apex blunt; radula as in *Helix*.

A family of minute mollusks.

Megaspira elatior, Spix., a forest snail of Brazil, is exceptional. It bears an auger-shaped shell, $2\frac{1}{2}$ inches long, of about twenty-five coils.

Genus PUPILLA, Leach (PUPA, Lam.)

Characters of the family. A large genus of universal distribution. The well-established name, *Pupa*, of Lamarck is obliged to give place to the earlier one, given by Leach.

The **Armed Chrysalis Shell** (*P. armifera*, Say) is almost thimble-shaped; inside the thick, recurved lip the aperture is guarded by numerous teeth and folded plaits. Animal black. Length, $\frac{1}{8}$ inch.

Habitat.— Damp soil about grass plots, or under logs. Eastern half of United States. A few other species are found in this country.

Genus VERTIGO, Müll.

Shell minute, ovate, with blunt apex; aperture with four to seven folds; lip expanded, white. Animal as in *Pupa*, but lacking one pair of tentacles. Distribution world-wide. One hundred species.

V. ovata, Say, dark amber-coloured, stout. with semi-circular, toothed aperture, and only $\frac{1}{8}$ inch long, is scarcely

large enough to catch the eye of the amateur. But it interests the collector, who has his mind on what of beauty and truth the microscope yields. This tiny mollusk hustles along at an awkward but speedy pace for a snail, alternately setting its snout on a spot and drawing the body up to it. Look for it in wet places along stream banks.

Habitat.—Maine to Texas.

Genus STROPHIA, Alb. (CERION, Mörch.)

Shell large, oblong, cylindrical, longitudinally ribbed or costate, solid, white; aperture oval; lip expanded; columella folded. Dentition as in *Helix*.

S. incana, Binn., is our only representative of this West Indian genus. It is found on low ground, or under stones, at Key West near tide marshes, and clinging to plants. In winter it secretes an epiphragm of thin membrane. The chalky, solid shell is sometimes streaked with reddish brown. Length, 1 inch.

Habitat.—Florida Keys.

S. decumana, Fér., of the Bahamas, has the form of a silkworm's cocoon, but is white, and pierced by a tubular umbilicus.

This is one of the largest species.

S. chrysalis, Fér., blunt, stout, its flat coils strongly cross-ribbed and spotted, is a Cuban chrysalis shell. Length, $1\frac{1}{2}$ inches.

THE DOOR SHELLS

Genus CLAUSILIA, Drap.

Shell slenderly fusiform, usually sinistral, aperture ear-shaped, guarded by wall ridges, and closed by a shelly plate attached to the columella by an elastic foot. It is for the exclusion of small beetles and other insects. A genus of seven hundred species, all terrestrial, with shells mostly turned to the left.

The **Three-Toothed Door Shell**, (*C. tridens*, Chemn.), slim, brown, with a flaring, three-toothed, white lip, has its six whorls longitudinally grooved, and its tip rounded to a blunt point. Length, $1\frac{1}{2}$ inches.

Habitat.—West Indies.

CHAPTER LXXI: THE LAND SLUGS

FAMILY LIMACIDÆ

SHELL present or absent, internal or external, respiratory cavity under mantle; radula and jaw well developed. Chiefly herbivorous mollusks, creeping about in woods and gardens, after rains, at dusk, or while the dew is on the ground. Some suspend themselves by glutinous threads from twigs or leaves.

Genus LIMAX, Linn.

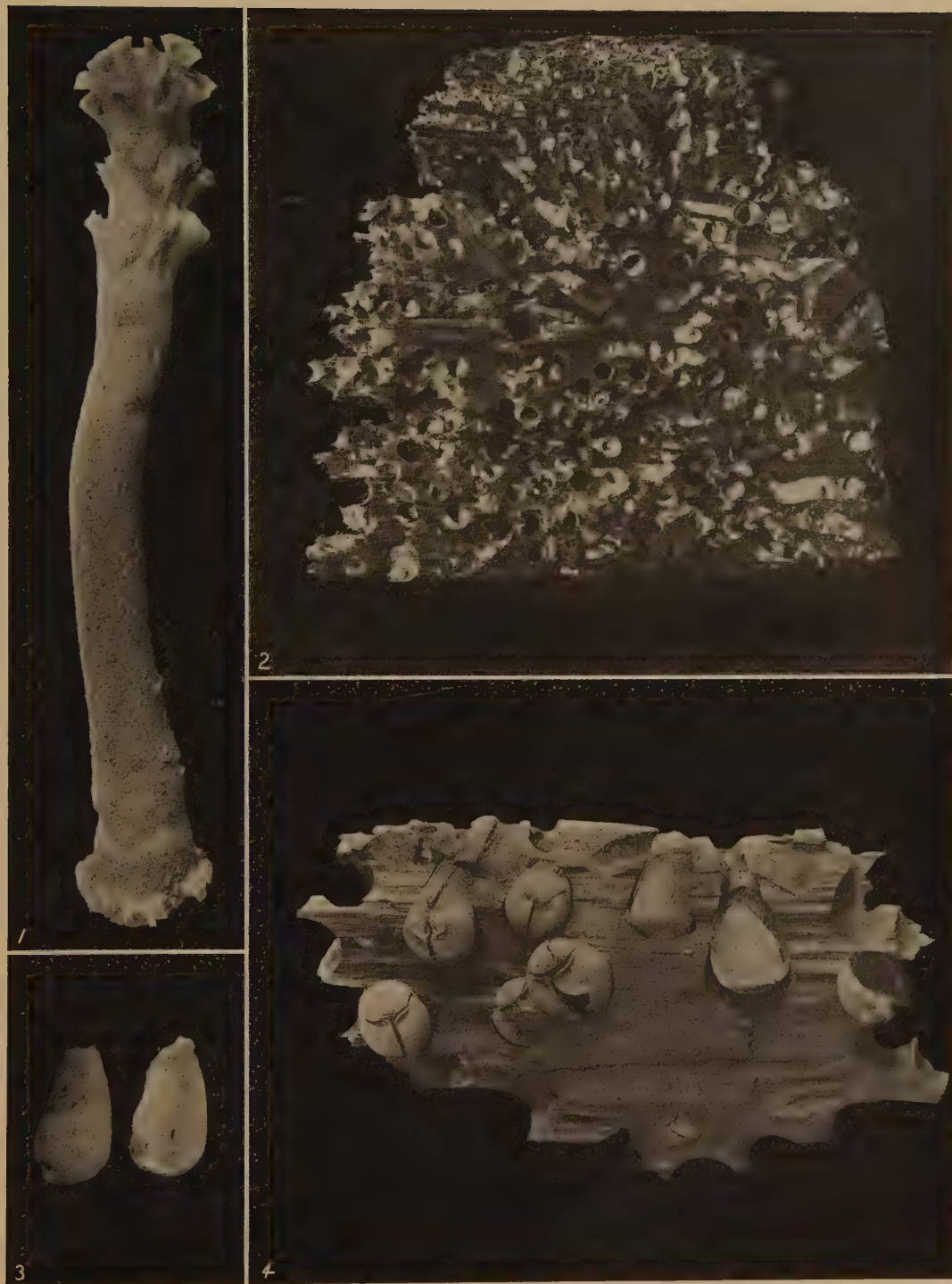
Shell rudimentary, oblong, flattened, thin, behind the head, and buried under mantle; body long, flexible, keeled, with eyes on tips of upper pair of tentacles; jaw smooth, arched and beaked. Mantle free in front, with orifice of long sac near the right posterior margin.

Nocturnal mollusks with keen smell, sight and hearing, which like damp places and lay their eggs underground. Toads and frogs eat them.

The **Great Gray Slug** (*L. maximus*, Linn.) is five or six inches long when it stretches itself out at full length to rest after a toilsome journey after food. The slimy trail is an exudation of mucus, from a gland. The rounded body is ashen or pale brown, alternately striped and dotted.

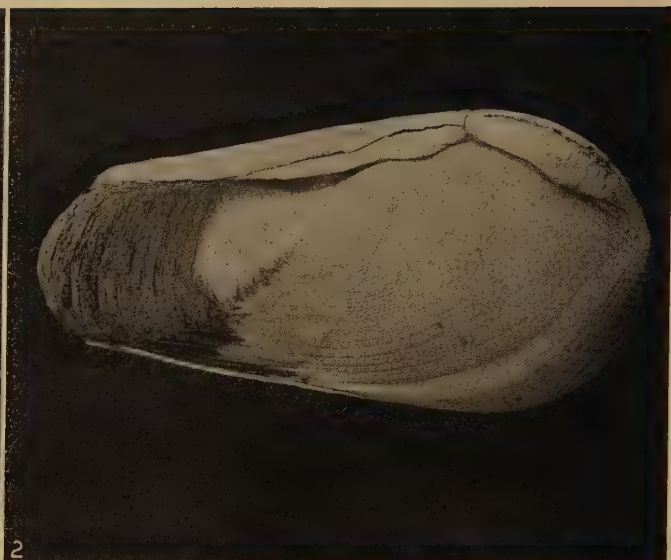
M. Moquin-Tandon noticed one rainy day in the botanical gardens at Toulouse, two *Limax maximus* approaching a rotten apple from different directions. He changed the position of the apple several times, placing it at a sufficient distance to be sure they could not see it, but they always hit it off correctly, after raising their heads and moving their long tentacles in every direction. It then occurred to him to hold the apple in the air, some centimetres above the head of the *Limax*. They perceived where it was and raised their heads and lengthened their necks, endeavouring to find some solid body on which to climb to their food.—*Cooke*.

The senses of smell and sight are lost in slugs from which the tentacles are cut.



WOOD-BORING BIVALVES

- 1 Watering-pot Shell, *Aspergillum vaginiferum*.
- 2 Fragment of wood bored by Ship-worm, *Teredo navalis*.
- 3 Wood-eating Piddock, *Xylophaga dorsalis*.
- 4 Same, showing depth of burrows, and position, across the grain.



PIDDOCKS. ROCK-BORERS

- 1 Rough Piddock, *Zirphæa crispata*.
 2 California Piddock, *Parapholas Californica*.

- 3 Arctic Piddock, *Saxicava arctica*
 4 Angel's Wings, *Pholas costata*.

The gardener who kills this slug does himself and the mollusk an injustice. It is known to eat raw meat, live snails and slugs not excepted. It invades dairies to sip the cream, of which it is desperately fond. It eagerly eats flour and meal. It climbs into the kitchen garbage can, and culls such fragments as bread and butter, meat scraps, fat and cheese. The red binding of certain books was chewed off by night, in one instance. The only food it will not touch is the green substance of growing plants. Hence it is preëminently the gardener's friend. It is not surprising to learn that the introduction of this species into America came through greenhouses to which they were brought by gardeners trained in the old countries. It is found in the neighbourhood of large cities in the east and on the Pacific coast.

L. campestris, Binney, is a western slug closely related to the preceding species. Its body is almost transparent, one-coloured, amber to black, cylindrical, one inch long, with a scant supply of watery mucus.

Habitat.—New England to California.

L. montanus, Eng., is a stout, bluish slug an inch long, found in the highlands of Colorado and Montana.

The **Yellow Slug** (*L. flavus*, Linn.) has a meddlesome habit of poking its nose into meal and flour bags and bins, hunting "broken wittles" in garbage cans, and nibbling the tender leaves of growing vegetables.

This is easily the most beautiful of slugs. Its keeled back is yellowish brown with oval white spots on the body and round ones on the mantle. The tentacles and sole of the foot are white, the head and eye stalks are semi-transparent and bluish. Length, 3 inches.

Habitat.—Europe. Introduced into eastern cities of the United States.

The **Field Slug** (*L. agrestis*, Linn.) is the pest of gardens and greenhouses, coming out at night to devour tender seedlings, succulent vegetables and ripening fruits, even damaging field crops, such as peas, clover and oats.

Near our eastern seaboard cities this slug is common in cellars and under decaying boards about barnyards. Many congregate in one place, from which they rapidly scatter when disturbed. They hang head downward by mucous threads from plants and fence rails, especially in damp weather. The

The Land Slugs

time required to reach maturity is about eighty days. Each individual lays several hundred eggs in a year. This is the most prolific of all the slugs, therefore the most difficult to deal with.

This unwelcome immigrant may be recognised by its grooved and tubercled back, which ranges from white to black, through yellow and brown. Its plentiful slime is white and viscid. It eats earthworms and insects beside its regular diet. This species is about $1\frac{1}{2}$ inches long. It is native to Europe, but naturalised in this country.

These are the slugs sold in British towns on the prescription of physicians, and thoroughly believed in by the country folk as "good for consumption." They are swallowed alive, or first boiled in milk.

Pliny recommends "a plaister made of slugs with their heads cut off" to be bound on the forehead as a cure for headache. He thought slugs were young snails not yet old enough to have secreted shells.

Genus ARION, Fér.

Shell wanting, or resolved into several granules; body slug-like, narrow, furrowed; mantle small, free in front and on sides, orifice of lung sac near fore part, slime gland in the tail, secretion viscid, transparent.

A small genus native to the eastern hemisphere, but with representatives naturalised in this country.

The **Large Black Slug** (*A. ater*, Linn.) has no friendship with gardeners, but a standing feud. By day and by night the creature eats, exhibiting a voracity that is rarely equalled. Our quarrel is based upon the fruit it steals, but its diet is remarkably varied. In captivity a specimen consumed the following items: five other slugs, a dead mussel, some insects, and a little toilet soap. It accepted also various garden vegetables, dead mice, birds, earthworms, bread, wild plants, including several mushrooms, some poisonous, leaves of polypody fern, sea holly and buttercup. After a two-days' fast one scraped the news off a portion of the daily paper. Another fed eagerly on a handful of beach sand. Slugs can go hungry for days at a time, but they must have water, or they die.

A full grown slug will reach five inches in length. The body is covered with a shingling of papillæ, but no furrows. In colour

it is white, yellow, brown or black, according to the food plants and the moss and leaves among which its life is spent.

The Arions are late in going into hibernation, sustaining a much greater degree of cold than the shell-bearers. The eggs are laid at intervals covering several weeks, an individual producing several hundred. They hatch in forty to sixty days. The young slug buries itself in the ground for four or five days, and emerges nearly twice its original size. The adult slug, after laying its eggs, frequently dies from sheer exhaustion. The weight of the eggs laid often exceeds three-fourth of the slug's own weight.

In every batch of slug's eggs many are devoured by the larvæ of a small fly which lays its eggs inside after puncturing the thin shell. Centipedes, ants and other insects devour the young. So do other slugs, and birds have a great liking for them.

A favourite pastime with *A. ater* is to take a bath. It often remains under water for hours. One specimen, submerged and held under for three days, did not perish, but recovered in short order. Small parasites make life miserable for many a healthy slug. They may be seen swimming in a beaker into which a slug is put for a bath. Perhaps bathing is the practical means of getting rid of these pests.

A slug will often eat the slime and even the skin off the back of another. Though this is certain death to the victim, he stands still, making no objection, and seeming quite indifferent to the business which gives his companion so much pleasure.

Genus **ARIOLIMAX**, Mörch.

Mantle with free edges all around, and contains a stiff plate of limy composition; body slug-like, blunt.

The **Great Yellow Slug** (*A. Columbianus*, Gld.) frequents damp, shady places throughout the year on the Pacific coast, and spends the rainy months in the fields. It is attracted by such a bait as a bit of orange peel or a dish of milk. The many-toothed radula and cross-ribbed jaw are fitted for a vegetable diet. Length, 4 to 6 inches. California northward.

The **Black Slug** (*A. niger*, Cpr.) is dark, as a rule, with a narrow, long body, blunt in front, two inches long when crawling, an inch long or less when drawn up under shelter to rest.

Habitat.— Central California.

CHAPTER LXXII: THE AMBER SNAILS

FAMILY SUCCINEIDÆ

SHELL oblique, spiral, thin, transparent, of few coils. A family containing several genera of slug-like mollusks.

Genus SUCCINEA, Drap.

Shell oval, fragile, glassy, spire short, whorls few. Animal large, barely covered by shell; foot broad; tentacles short, thick. lower pair dwarfed.

Large genus of two hundred species, distribution universal. Terrestrial, but living in damp places near margins of streams.

The **Oblique Amber Snail** (*S. obliqua*, Say) is greenish yellow or amber-hued, fragile, rosy at apex; the enlarged body whorl forms nine-tenths of the shell. The rounded whorls are drawn in by a deep suture. The body is somewhat longer than the shell. Though this mollusk wanders sometimes on hillsides away from streams, doubtless it finds the needed moisture, even in the dryer situations. Length, $\frac{3}{4}$ to 1 inch. Mississippi Valley.

The **Oval Amber Snail** (*S. ovalis*, Gld.) has its outer lip drawn out until the shell is shaped like a sugar scoop, revealing the interior of the small spire. It is not easy to detect these little snails as they glide over the stems of aquatic plants, or ride on pieces of floating wood. The body and shell both have a translucent horn colour. The oval eggs, laid in June, in clear masses at the roots of aquatic plants, number about twenty. Length, $\frac{3}{4}$ inch. Canada and Northeastern States.

Hayden's Amber Snail (*S. Haydeni*, Binney) is more slender than *S. obliqua*, with lip much extended, revealing the interior of the spire. This is the largest known American Succinea. The shell has a uniform amber colour. Length, 1 inch. United States, central and northern portions, west to Utah.

The **Rustic Amber Snail** (*S. rustica*, Gld.), with a greenish, horn-coloured, rough, lustreless shell, is fragile like the rest. Length, $\frac{1}{2}$ inch. Oregon, California and Nevada.

CHAPTER LXXIII: THE EAR SNAILS

FAMILY AURICULIDÆ

Genus AURICULA, Linn.

SHELL spiral, cone-shaped, usually solid, stout to slender; internal partitions usually absorbed; aperture ear-shaped, strongly defended by teeth; lung present; head bears snout and two dilated buccal lobes; teeth very small, numerous; upper jaw semi-lunar, horny; eyes sessile on bases of tentacles; mantle thickened at margin, closed; respiratory orifice posterior, on right side; sexes united.

Nearly all of this family have the habit of absorbing the internal coils of the shell, and using the material to thicken the remaining parts. The soft parts necessarily lose their spiral form when their support is gone.

The lung is actually a spongy mass of air sacs, not merely a hollow pouch. These amphibious mollusks require nearness to sea. The large and brilliantly coloured species are tropical, centring in the Pacific Islands.

A. Judæ, Lam., a thick-shelled, horn-coloured, ear snail, with white lips, creeps through the slimy mud among the roots of mangrove trees. Its tentacles are stubby, and its eyes have been lost through disuse. Length, 2 inches. Philippines, Australia, Borneo.

The **Midas's Ear** (*A. auris-Midæ*, Linn.) is heavy, elongated, with polished, golden brown epidermis covering the pale, cancellated surface. The white or creamy lining is thickened all around the aperture, and usually raised in two folds near the base of the columella. The reflected callus often overlies the small umbilicus. A fold almost amounting to a varix indicates the last place where growth was resumed. Length, 3 to 4 inches. New Guinea.

Genus CASSIDULA, Fér.

Shell solid, square-shouldered like *Cassis*, last whorl large; outer lip thickened and strongly toothed; columella bears sharp-toothed folds; aperture narrow.

The Ear Snails

C. angulifera, Petit, has its angled shoulder outlined with a white band, on a ground of pale chestnut or chocolate. The animal walks on the submerged beach when the tide is in, or scrambles over arching mangrove roots, and among stones back from the water line, indifferently terrestrial and aquatic in its habits. The slim tentacles bear eyes at their bases. The foot is cleft behind. Length, 1 to $1\frac{1}{2}$ inches.

Habitat.—Australia.

Genus SCARABUS, Montf. (PYTHIA, Bolt.)

Shell oval, laterally compressed, forming two series of varices on the conoidal spire; umbilicus rimate; aperture narrowed by thickened, strongly folded and toothed lips; outer lip much expanded. Terrestrial mollusks living in dark places in woods near shore, coming out after rains. Eggs are laid on tree trunks.

Habitat.—Tropical islands in Old World.

S. Lessoni, Blainv., is mottled brown and yellow above, with a pale bluish bloom replacing the yellow on the side on which the mouth opens. It resembles certain birds' eggs. The generic name may be derived from a resemblance to the polished wing covers of beetles, of the genus *Scarabæus*. Length, 1 inch.

Habitat.—Molucca Islands.

Genus MELAMPUS, Montf.

Shell ovate-conical, spire short, blunt; aperture narrow, both lips crossed by several toothed folds. A widely distributed genus, chiefly tropical, living on rocks or on the rank growths above tide water, where they are dashed with salt spray. They seem intermediate between marine and terrestrial forms.

The **Coffee Melampus**, (*M. coffea*, Linn.) is larger and paler than a grain of coffee, and spirally three-banded with white on its fawn-coloured body whorl. Deep in the narrow aperture is a thick white callus with about twenty cross ridges opposite the columella which bears a small ridge at the anterior end of the sharp peristome, and a much larger white fold considerably higher up. Indians used to string and wear as beads this little West Indian ear snail, which is rarely found on the gulf side of Florida. Length, $\frac{3}{4}$ inch.

M. bidentatus, Say, is the commonest salt marsh snail on the Atlantic and Gulf coasts. It climbs the marsh grasses at high tide as if to escape a ducking. The white cross folds deep in the outer lip and two tooth-like folds on the columella are characteristic of them all. The shells are thin and horn-coloured, broadly ovate, square shouldered, polished and often banded when young. Adult shells are corroded and coated with muddy deposits. Length, $\frac{1}{2}$ inch.

Habitat.— New England to Texas in salt marshes.

M. olivaceus, Cpr., is a plump oval shell, smooth, dirty white banded or splotched with purple, under an olive green epidermis. The aperture is white, with sharp cross folds within the outer lip, and a single central lamina prominent on the columella. Length, $\frac{1}{2}$ inch.

Habitat.— San Diego, Cal.

CHAPTER LXXIV: THE POND SNAILS

FAMILY LIMNÆIDÆ

SHELL fragile, variable in form, horn-coloured, usually with an oblique fold on the columella; outer lip simple, acute. Head with broad muzzle, dilated at the end; mouth with one or more jaws, radula armed with numerous quadrate teeth; tentacles flattened, eyes sessile at inner bases of tentacles; foot flat; respiratory orifice on right side. Sexes united.

Fresh water mollusks, which come to the surface to breathe fresh air, and feed on confervæ and other aquatic plants and small animal forms. They form an important staple in the diet of fishes, frogs, toads and birds, including coots, rails and others that frequent ponds and streams. In winter they bury themselves in mud. Distribution universal.

Genus LIMNÆA, Linn.

Shell dextrally spiral, oblong, translucent, with thin epidermis, last whorl large; aperture large, roundish; lip simple; columella with one oblique fold. Tentacles flattened, triangular; mantle edge thickened; foot short, rounded. A world-wide genus, preferring the north temperate zone. In North America it reaches its maximum size in the region of the Great Lakes.

Left-handed Limnæas occur in the Sandwich Islands and New Zealand. The genus is represented in hot sulphur springs in Iceland, and in Lake Geneva at a depth of 800 feet. A species is found in Thibet at an altitude of 14,000 feet. Another creeps over ice fields in northern Asia, and is frozen in solid blocks of ice ten months in the year.

The **Great Pond Snail** (*L. stagnalis*, Linn.) has spread from Europe throughout the northern hemisphere. In North America it is found in still water and in quiet streams from Greenland to Alaska and south to Texas. In winter it is frequently seen creeping along the under side of the icy crust of a brook.

The spire of this snail tapers above the large body whorl to a needle-pointed apex. The whorls are rounded and separated by a deep suture. The outer lip is thin and does not flare. The columella is somewhat callous, and bears a strong oblique fold. The yellowish brown surface is coated with an epidermis, which is usually worn off on the spire, and the shell substance corroded by carbonic acid in the water.

The body is yellowish gray; the broad foot is edged with yellow. The large square head bears pointed tentacles that broaden toward their bases. The largest specimens are two inches long. Half-grown shells are transparent and more slender than the adults.

L. stagnalis is a general feeder, exhibiting decided carnivorous tastes, though it is generally rated a vegetarian. In the fresh-water aquarium this bloodthirsty snail attacks newts and sticklebacks and contentedly picks their bones. Larvæ of water beetles and other insects have also been its victims, and even its own young are not exempt. These depredations are not justified on the grounds of hunger. Plenty of its favourite vegetable food was in the jar. It is strange that a snail is able to capture creatures so strong, so agile and in some instances so well armed. In a pond in England an old newspaper was found to be covered with snails which were hungrily feeding upon its substance.

The eggs are laid in cylindrical masses, counting from fifty to one hundred or more. The young grow most lustily in large ponds and streams. It is a fact well established by scientific tests that "rate of development and ultimate size attained are in direct proportion to the volume of water in which the individuals have lived." It is not surprising that so susceptible and so cosmopolitan a species should exhibit infinite variations.

The **Dwarfed Limnæa** (*L. truncatula*, Müll.) means no harm at all, but it probably works more harm to the human race than any other mollusk. And this by being the innocent victim of one of Nature's cruel conspiracies, which gives the victory to a disgusting parasite.

Our little *truncatula* has a pointed, conical shell not over half an inch high, with shiny, deeply sutured whorls, and a distinct umbilicus. It scrapes the yellow-green algæ from the surface of ditches and ponds, "askin' nothin' f 'm nobody." But around it swim the ciliated embryos of *Fasciola hepatica*: a single adult

lays half a million eggs. A strange instinct leads these microscopic "whirling dervishes" to climb into the air chambers of the snails. They stab the flesh with horns like a unicorn's, that work in, being barbed. The scramble is justified. If the embryo has not found its host in eight hours after hatching, it dies. No other species of snail is attacked.

Three stages of its life are passed, three generations of progeny developed, within the body of this long-suffering snail. From the liver the parasites pass out. Following their fateful programme they at once climb upon the stems of marsh grasses and encyst themselves for a dormant period that may never end.

Sheep are turned in autumn into pastures where grass is still green, and there is water. They eat the herbage, and a great many of the infested snails, besides the incysted forms of the parasite, put there as if for their especial benefit. Freed of their cysts and stimulated to wonderful activity in the stomachs of the sheep, the invaders pass to the liver, where as mature "liver flukes" they set up destructive changes by the symptoms of which the experienced farmer at once recognises the deadly disease called "rot." Three million sheep died from this cause alone in the winter of 1879-80 in England. The eggs produced in the liver of the sheep and excreted with the manure, await the coming of spring, when the deadly cycle of another generation begins.

Sheep kept away from marshy pastures escape the scourge. Salt is a tested prophylactic.

L. auricularis, Linn., a species easily distinguishable by its greatly expanded mouth, looks like a limpet with a spire attached on one side. This European species has an American counterpart in *L. ampla*, Mighels, which has a less exaggerated, but still very ample mouth, and a much inflated body whorl. Length, $1\frac{1}{2}$ inches. Eagle Lake, Maine.

L. columella, Say, is oval with an acute elevated spire, and large oval aperture. Columella so narrowed that one can see the interior almost to the apex. Length, $\frac{7}{16}$ inch.

Habitat.—Miry places and stagnant waters. New England and Lake Superior to Georgia.

L. palustris, Müll., oblong, with acuminate spire and much elongated and swollen body whorl, is a European species, found also from New England to the Pacific states. It is variable, averaging an inch in length.

L. gracilis, Jay, has but four or five whorls, but is seven times as long as broad. It might be called "the needle pond snail." The aperture is elongately oval, and has no fold. Colour, white. Length, 1 inch.

Habitat.—Lake Champlain, Wisconsin and Ohio.

THE POUCH SNAILS. BLADDER SNAILS

Genus *PHYSA*, Drap.

Shell sinistral, oblong, thin, polished, of few whorls; aperture oval, anterior margin not dilated; outer lip acute; inner lip reflexed over columella; foot long, pointed behind; mantle margin fringed, reflected over shell edges; tentacles, long, thread-like. Distribution world-wide. More active mollusks than the *Limnæas*, both in walking and in gliding with shell downward on the surface of the water. They descend and ascend on threads of mucus.

The best way to study these little pouch snails is to get a few full grown ones in spring, place them in a tumbler or fruit jar of pond water, with a pebbly bottom, and a little pond weed lying on the bottom. The spawn will be extruded, and the young hatched. As they develop they constantly travel about on threads.

A writer in the *Quarterly Journal of Conchology* makes some interesting observations upon these agile little "bladder snails":

Often when two *Physæ* meet upon the same thread they fight as only mollusks of this genus can, and the manœuvres they go through upon their fairy ladders outdo the cleverest human gymnast that ever performed. I once saw one ascending, and when it was halfway up the thread it was overtaken by another; then came the "tug of war"; each tried to shake the other off by repeated blows and jerks of its shell, at the same time creeping over each others' shell and body in a most excited manner. Neither being able to gain the mastery, one began to descend, followed by the other, which overtook it, reaching the bottom first.

Yet they are not always bent on war, but pass and repass each other in an amicable spirit. One of the most beautiful sights in molluscan economy is to see these little "golden pippins" gliding through the water by no visible means; and when they

The Pond Snails

fight, to see them twist and twirl, performing such quick and curious evolutions while seemingly floating in mid-water, is astonishing, even to the patient student of Nature's wonders.

Dr. Jeffreys says that all snails clean each others' shells of confervæ, the passive individual remaining patiently quiet while the "operator" goes over the entire surface with its rasping tongue.

P. hypnorum, Linn., described as a gymnast above, is the most rapid of all aquatic snails. It cleans its own shell to the very apex. European species found also in America.

The **Tadpole Pouch Snail** (*P. gyrina*, Say) is an inch long, the last of the six whorls very large, the oval aperture nearly two-thirds the length of the shell. The lip is slightly thickened within, the columella overlaid with a callus.

Habitat.—Vermont and Georgia, westward.

The **Jug Physa** (*P. ampullacea*, Gld.) is a shining, delicate, much swollen species, its lip tinged with red. The aperture is wide and about five-sixths the total length of the shell. The columella is deeply excavated anteriorly. Length, 1 inch.

Habitat.—Oregon, Washington.

P. ancillaria, Say, has a dainty, flesh-tinted, translucent shell with an inflated body whorl, and an oval aperture a trifle shorter than the shell. Both lips are slightly thickened with a white callus. The apex is blunt and dark.

This species is numerous on piers of wharves in eastern rivers, going up and down with the turns of the tide. It also burrows in mud as soon as the water goes off, reappearing as the water rises. Length, $\frac{1}{2}$ inch.

Habitat.—New England to Louisiana.

The **Small-mouthed Physa** (*P. microstoma*, Hald.), is a brownish yellow, elliptical, solid shell, with aperture contracted, lip thickened, and columella bearing two pearly teeth. Length, $\frac{2}{3}$ inch.

Habitat.—Kentucky, Ohio.

THE ORB SNAILS. TRUMPET SNAILS

.Genus PLANORBIS, Guettard

Shell a flattened, bi-concave, dextral coil, spire depressed; aperture small, rounded; margin simple, upper margin produced.

Animal with short, ovate foot, short head and slender tentacles. Sluggish snails, in stagnant or slow running water. Distribution world-wide.

The **Three-coiled Orb Snail** (*P. trivolvis*, Say) is found in almost every pond, stream and ditch in this country, and should be popularly known. Its rounded coils increase with age, so the spire is at the bottom of a cup-like depression opposite the umbilical pit. Fine, close-set, knife-edged striations cross the whorls. The lip is callused within. Diameter, 1 inch.

Habitat.—Canada and United States.

P. campanulatus, Say, has a bell-shaped aperture. Length, $\frac{1}{2}$ inch.

Habitat.—New England to Minnesota.

P. bicarinatus, Say, has two distinct keels and an enlarged aperture with angled lip. Diameter, $\frac{1}{2}$ inch.

Habitat.—Canada to Kansas and Georgia.

Shells of Planorbis are delicate and easily warped in growth, so many monstrosities are found. Doubtless many named varieties are erected upon abnormal individuals.

THE SHIELD SNAILS. RIVER LIMPETS

Genus ANCYLUS, Geof.

Shell patelliform, not spiral, thin; apex sinistral; jaws, three; radula broad, crowded with teeth; foot large; mantle included; tentacles triangular; pulmonary orifice protected by a flap.

A. rivularis, Say, has a horny, opaque shell, with blunt, sub-central apex. The large, oval aperture narrows at one end. Lining white. This is found adhering to stones in rivulets. Length, $\frac{1}{4}$ inch.

Habitat.—Massachusetts, Virginia, Wisconsin.

A. Newberryi, Lea, is a large blunt dome, smoky red, with sides somewhat compressed, making an elliptical aperture. This is easily the largest species in the genus. Length, 1 inch.

Habitat.—Lake Klamath, Cal,

CHAPTER LXXV: THE SIPHON SHELLS

FAMILY SIPHONARIIDÆ

Genus SIPHONARIA, Blainv.

SHELL patelliform, apex sub-central, posterior muscle scar horse-shoe shaped, divided on the right by a deep siphonal groove. Animal with broad two-lobed head; no tentacles; rudimentary branchiæ form triangular folds of the lining membrane of the mantle. Marine mollusks chiefly of the Tropics, living attached to rocks between tide marks, or if higher, where they are dashed occasionally by spray.

S. gigas, Sby., has a solid, porcellaneous shell, polished within and shaded to black at the margin. Exterior dingy, thrown into many sharp-edged plaits, becoming worn with age. Length, 2 inches.

Habitat.— Panama.

S. alternata, Say, has a backward pointing beak, drawn almost as far from the centre as the margin of the shell. Fine lines sculpture the basal half of the cone. Colour brown, with radiating lines of white. Base oval. Diameter, $\frac{3}{16}$ inch.

Habitat.— East Florida.

PART III

THE TOOTH SHELLS; CLASS SCAPHOPODA

THE TOOTH SHELLS

CLASS SCAPHOPODA

SHELL tubular, tapering, curved, open at both ends; 1 to 5 inches long; body elongated, curved, symmetrical, attached to shell by muscles near posterior end; mantle lines shell, forms tube which flares at anterior end; surface absorbs oxygen, acting as organ of respiration; head rudimentary; eyes none; foot long, pointed; mouth at base of foot contains radula; filaments for seizing food are grouped at corners of mouth; stomach and intestine simple; liver large, two-lobed, much-branched; kidneys, two, large; reproductive gland large, much elongated in posterior end of shell, discharges through right kidney; sexes separate; heart rudimentary, one-chambered; arteries none; gills none; brain a very small ganglion, connected with four others. Food, small infusorians and other microscopic organisms. Habitat, sandy or muddy sea bottom, from shallows into very deep water. Distribution world-wide in seas. Shells used for money and for personal adornment by primitive tribes.

FAMILY DENTALIIDÆ

Foot partially enclosed by a fleshy sheath, which is cleft into two terminal lobes; shell tusk-shaped, ribbed, strong, like ivory in texture.

The most important family in the class. It includes a single genus of about one hundred and fifty living species.

Genus DENTALIUM, Linn.

Characteristics of the family.

The Dentalium burrows into the sand of the ocean floor, until it lies, head downward, in a slanting position with the little end of its shell thrust up into clear water, and the mantle spread,

The Tooth Shells

to act as a gill. There is no eye, nor any need of one, for the head is buried; but certain vibrating organs are believed to be ears. The captacula, or tentacles, feel around in the sand and capture the minute bivalves and Foraminifera on which the mollusk feeds.

Tooth shells have been used as money and as ornaments by tribes of Indians. The polished shells, perforated by nature as if for stringing, would suggest the possibility of a necklace to any child. They made the same appeal to Indians.

The **Money Tooth Shell** (*D. pretiosum*, Nutt.), is abundant along the Pacific coast north of California. It is pure white and polished and somewhat over an inch in length. It looks like an elephant's tusk in miniature. The Indians used to collect these shells by combing the sandy bottom with a long fine-toothed rake. The squaw slowly paddled the canoe over the shallows while the man operated the rake. If luck was good, a few shells came up with each haul.

Strings of tooth shells formed the currency of the Indians in the days before the Hudson Bay Company came. A string of twenty-five large ones might be worth the price of a canoe, or a comely squaw. This was about equal to two hundred and fifty dollars. The industrious beach-comber soon became a man of means.

Haik-wa, hai-qua or tusk shell money of the aborigines of the Pacific coast, was the equivalent of the wampum in use among the Indian tribes of the Atlantic coast. The California Indians had immense quantities of the "money shells" in circulation before they came into contact with civilisation. Powers says:

From my own observations and from the statements of pioneers and the Indians themselves I hesitate little to express the belief that every Indian in the state, in early days, possessed an average of at least \$100 worth of shell money. This would represent the value of about two women, or two grizzly bearskins, or twenty-five cinnamon bearskins, or about three average ponies.

The squaws strung the shells on a fine thread of deer sinew. The string was usually ornamented with bits of the pearly *Haliotis* shell and tufts of wool from the mountain goat.

The highest standard of currency was the hai-qua, or sovereign, valued at about £50 sterling. It was a string of twenty-five

shells, one fathom long, or equal in length to the extent of a man's outstretched arms. It required shells of large size and perfect form to reach this high standard. Smaller shells were of lower value. A fathom string of forty shells would buy a slave. Small and imperfect shells were strung together on sinew cords of different lengths. These formed the small change, "kop-kop," of the tribes.

The earliest white traders found that the Indians knew where and how to obtain gold from the earth. Learning that they held it in slight esteem, and that avarice with them expressed itself in a craving for strings of shell money, the traders managed to increase the quantity of shells by importing them from the east coast. These were readily exchanged for gold, to the great satisfaction of all concerned. The decline of the popularity of shell money dates from the coming of the trappers of the Hudson Bay Company. Blankets became the standard of value, and the medium of exchange among the Indians. Young men were quick to adopt the new custom, but old men held to the ways of their fathers, and became misers of shell money. In the more remote Alaskan tribes only is it found in circulation at the present day.

The **Angled Tooth Shell** (*D. hexagonum*, Gld.), found on the California coast, has a much more delicate shell than the more northern species. It is distinctly six-angled by ridges extending its whole length. Length, 1 inch.

The **Common Tooth Shell** of warm European waters is *D. vulgare*, Da Costa. Its slim shell averages less than two inches in length. The shell is opaque, lustreless, whitish, with tinting of rose or yellow toward the apex, and often has indistinct dusky bands crossing the fine longitudinal striæ. The aperture is circular and oblique, not notched. Jeffreys characterises this little creature as a "fastidious Pig from the herd of Epicurus, luxuriously picking out the choicest morsels with its extensile and delicate captacula." He found only shore forms of Foraminifera in the stomachs of specimens examined.

The largest and finest shells of this species are collected on the Adriatic shores. They are sometimes over two inches long.

On the colder coasts of the Atlantic on both sides the commonest species is *D. entalis*, Linn. (This is identical with *D. striolatum*, Stimps., and *Entalis striolata*, Stimps.) Its shell is white, but more glossy and ivory-like than that of *D.*

vulgare. The longitudinal striæ are wanting almost entirely, and distinct segmentation of the shell is often made by the lines of growth. The anterior margin is jagged, the posterior aperture is oblique and notched on the convex side. This is the familiar tooth shell of the New England coast and of the British Isles.

The **Elephant-tusk Shell** (*D. elephantinum*, Linn.) is well named. It is curved and tapers like the tusk of an elephant, is strong, and has the texture of ivory. Ten strong longitudinal ribs give it a corrugated surface. The usual colour is dark green, fading to white at the apex. Transversely the ridges are crossed occasionally by bands that limit the annual growth of the shell. These strikingly handsome tusk shells come from the Orient, notably from the Philippine Islands. They are sometimes three inches in length.

D. aprinum, Linn., is a pea-green, glossy tooth shell of a slender, gracefully curving form, but strongly built. The 9 to 12 ridges are not so prominent as in the two preceding species; they are separated by wide, flat and highly polished intervals. These measure up to $2\frac{1}{4}$ inches in length. Diameter of aperture, $\frac{1}{4}$ inch. They come from the Philippine Archipelago.

The Japanese angled tusk shells resemble these in form, but they are white. They are of closely related species.

PART IV

THE BIVALVES. CLASS PELECYPODA

CHAPTER I: A TYPICAL BIVALVE MOLLUSK

THE hard shell clam of the east coast of the United States exhibits the structural plan of bivalve mollusks.

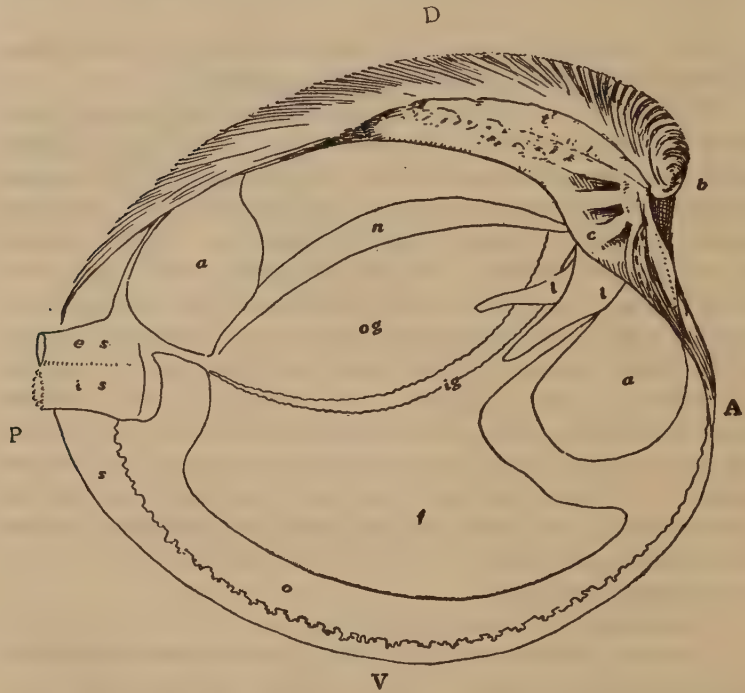
THE SHELL.—It is an oval box, somewhat flattened, composed of two symmetrical concave valves, joined by a ligament and locked hinge teeth at the back, and internally by two strong muscular cross bands, one at each end of the shell. The oval outline broadens at the anterior, or front end. The posterior, or hind end, is narrowed. The dorsal margins of the valves unite on the hinge line. The ventral margins are free and open. A swelling, the umbo, or beak, is seen on each valve well forward on the dorsal margin. Each umbo (pl. umbones) is more or less pointed. Lines of growth, concentric, and parallel with the outer, free shell margins, are seen on the outside. The surface has more or less of the horny epidermis overlying the lines of growth. The left valve is in your left hand when you hold the clam between your palms with the hinge line uppermost and the beaks pointing toward you. A heart-shaped imprint, the lunule, is seen below the beaks.

Examining the inside of an empty valve, note the anterior and posterior adductor muscle scars, two prominent patches at the ends of the expanse of enamel lining. Dorsal to each is the scar of a small foot muscle. The curved pallial line, parallel with the ventral margin, joins the two large muscle scars. It dips in at the posterior end, forming the pallial sinus. The thick edge at the hinge shows teeth that lock together. The ligament, a narrow, blackish, rubbery band, is fastened externally to both valves, from the hinge backward. It springs the valves slightly apart at the ventral margin. In order to close the valves tightly together the clam must contract the adductor muscles, and stretch the dorsal ligament. The normal position of the valves is slightly open. Closing them puts a strain upon muscles and ligament.

THE SOFT PARTS.—By severing the adductor muscles with a knife blade close to the left valve, and then breaking the ligament, the soft parts of a live clam are revealed, lying undisturbed

A Typical Bivalve Mollusk

in the right valve. The mantle spreads over everything. It lines each valve, and is attached to each along the pallial line. Outside this it hangs free as a thickened frill. At the posterior end of the body the two mantle edges unite to form two tubes.



PARTS OF HARD SHELL CLAM (*Venus Mercenaria*)

<i>A</i> , anterior end	<i>a, a</i> , adductor muscle scar
<i>P</i> , posterior end	<i>b</i> , beak or umbo
<i>D</i> , dorsal side	<i>c</i> , hinge teeth
<i>V</i> , ventral side	<i>t</i> , hinge ligament
<i>es</i> , excurrent siphon	<i>l, l</i> , labial palpi
<i>is</i> , incurrent siphon	<i>f</i> , foot
<i>ig</i> , inner gill	<i>o</i> , border of mantle
<i>og</i> , outer gill	<i>s</i> , shell border
<i>n</i> , gill chamber	<i>Ab</i> , lunule

Through one, the incurrent siphon, water passes into the mantle chamber. Through the other, the excurrent siphon, water is discharged. When withdrawn these tubes occupy the pallial sinus. The siphons are always behind.

By throwing the mantle back over the dorsal margin of the valve, the left gills, two layers of brown plate-like membrane, of basket-work texture, appear. They are attached along their dorsal margins to each other, to the body underneath, and to the mantle above them. The right gills are like them. The central space between the two valves is occupied by the body of the clam, the visceral mass. Its ventral part is the oblique, muscular foot. Above the foot the kidney, liver, stomach and heart are embedded in the fleshy mass. At the anterior end two flaps, the labial palpi, conceal the mouth.

The bilateral symmetry of this mollusk is evident. The central body is flanked on each side by a pair of gills, a mantle and a hard valve. Right and left, the halves of the body are alike. In this particular the univalve exhibits a marked difference. Clams have no heads, no tentacles, no eyes.

The alimentary canal begins with the mouth, situated between the flapping palpi. There is no jaw nor radula. The muscular œsophagus widens into a pouched stomach, from which the intestine extends downward into the foot, and after several convolutions passes backward, through the heart, ending in the excurrent siphon. The liver surrounds a portion of the stomach.

The inner wall of the intestine is folded to increase its secretory surface. In the stomach and intestine is found a gelatinous, transparent substance called the crystalline stylet, which often fills the space completely. Nobody knows the origin or the use of this strange body. It may be a reserve store of food, partially digested. It dissolves gradually when food is withheld, and reappears when feeding is resumed. It may protect the stomach walls from injury by sharp food particles. This is but one of many unsolved problems in molluscan anatomy. The digested food is absorbed by the veins in the intestinal walls.

Breathing and feeding are closely allied processes, for the inflow of water supplies the gills with oxygen and the stomach with food. The gills are four in number, and each consists of a double fold of delicate membrane. This membrane is composed of parallel gill filaments, united by connective tissue, bent back upon itself and stayed with cross bands between the two walls of the single gill. An intricate system of fine vessels distributes the blood through the gill substance, and an equally efficient system of tubes and pores admits water, so that the interchange of

A Typical Bivalve Mollusk

oxygen and carbonic acid gas goes on over an area greater many-fold than the visible surface of the gills.

Microscopic, transparent cilia, like the pile of velvet, stand erect on every part of the gill that comes in contact with the water. These hairs have the property of rhythmic wave motion, stroking strongly inward at the mouth of the incurrent siphon, and urging the water steadily through the complex channels of the gill substance. The stream, polluted by waste, makes its exit through the other siphon.

All the food the clam gets accumulates in the groove between the gill plates, and, too coarse to get through the pores into the network of the gills, it is worked along by the cilia to the palpi, and enters the mouth. Small infusorians, diatoms, the eggs and young of many sea creatures, decaying organic matter — all is grist for this mill. The clam does not choose its diet, but takes what comes its way. No need for teeth nor jaw. The digestive fluids prepare the food for use.

The heart lies in a loose bag, the pericardium, just anterior to the posterior adductor muscle. The single, muscular ventricle receives the pure blood from the lateral auricles, to which it flows from the gills. The intestine passes directly through the ventricle. The blood is distributed through closed tubes, arteries, which branch in the body tissues, and it is gathered into veins for return to the gills. The kidneys are complex organs that remove nitrogenous wastes. The mantle surface is richly supplied with capillaries. It supplements the work of the gills. Cold, colourless blood is the rule among mollusks.

In bivalve mollusks the sexes are usually separate. The reproductive glands lie near the kidneys, and discharge their products when mature into the posterior part of the mantle chamber, whence they pass out through the excurrent siphon. Fertilisation occurs in the water. In females the gills become brood chambers, distended with eggs in process of incubation. The young clams are free-swimming at first, but soon settle down, and take on the sedentary habits of the parent. Subsequent travel is accomplished by burrowing in mud or sand with the muscular foot.

The nervous system of the clam consists of widely separated ganglia, (little brains) connected by commissures, and sending out nerve ends to the surrounding tissues. There are two white,

A Typical Bivalve Mollusk

rounded ganglia the size of pin heads, on guard at the sides of the œsophagus. They are joined by a short cord, and send out two pairs of long cords. One pair pass to the pedal ganglion in the fleshy muscle of the foot. The other pair go to the visceral ganglion, in the posterior dorsal region. All the organs of the body receive nerves from ganglia or connecting commissures. The bivalve ear, when present, is in the foot, at the end of a nerve branch of the pedal ganglion.

Feeling is the most important sense to the bivalve mollusk. It is not centralised, but the mantle border, and the palpi, especially, are sensitive to touch. Eyes are wanting, except in rare instances. Taste and smell are probably not differentiated from the generalised sense of feeling.

CHAPTER II: THE WATERING-POT SHELLS AND CLUB SHELLS

FAMILY GASTROCHÆNIDÆ

Genus **ASPERGILLUM**, Lam.

SHELL small, both valves cemented to the walls of a trumpet-shaped tube, which bears several ruffles toward the large end; base of the tube is perforated and ornamented with minute tubes containing filamentous mantle processes. Animal elongated; foot finger-like; siphons two, long, contractile, united; mantle margin thickened, ruffled, reaching to end of tube. Twenty-one species. Gregarious burrowers in sand or mud. Red Sea to Australia.

The **Watering-pot Shell** (*A. vaginiferum*, Lam.) is a small affair always, but the long trumpet its mantle secretes reaches seven inches in length. The beaks of the two insignificant valves are visible near the base of the tube, where they are imbedded. A strange beast is this which outgrows its bivalve shell, and builds greater after a plan quite distinct from the bivalve pattern; all the organs of the body are changed to suit life in the new abode. The mollusks occur in numbers in sand and mud near low water mark; disturbed they retire within their stony citadels whence they are with difficulty extricated.

Habitat.—Red Sea.

THE CLUB SHELLS

Genus **CLAVIGELLA**, Lam.

SHELL with right valve free, left imbedded in tube; tube cylindrical, frilled above, base bordered with tubuli; mantle frilled, with tentacular processes. Six living and fourteen fossil species. Mediterranean Sea to Australia and Pacific Islands.

The Watering-pot Shells and Club Shells

The **Little Club Shell** (*C. aperta*, Sby.) has a much larger shell than the watering-pots. The valves seem external at the base of the club-shaped tube, though one is solidly fastened to it. Instead of full frills, numerous flaring rims mark periods of cessation of growth. After the valve becomes fixed, the animal ceases to burrow and secretes a strong flaring border to the tube. Sediment is deposited gradually about the valves, and the mollusk's method of overcoming this trouble is to build another story to his chimney, and again another as the deposit increases. Length of tube, 3 inches.

Habitat.—Mediterranean Sea.

CHAPTER III: THE SHIP WORM

FAMILY TEREDIDÆ

Genus **TEREDO**, Linn.

SHELL bivalve, globular, small; valves three-lobed, gaping, with interior spoon-shaped processes from the hinge; animal worm-like, in shelly burrow, with two long siphons, united almost to the ends, tipped with shelly pallets; orifices fringed.

The **Ship Worm** (*T. navalis*, Linn.) has long been known and dreaded as the treacherous destroyer of ships and wharves, which damages shipping in European and American ports continuously. Modern scientific researches have uncovered the methods of this mollusk, and devised a preventive of depredations from it.

The life history is most interesting. There is a brief, free swimming period, during which the infant borer has eyes, which disappear in later life. When the size of a pin head, the young settle on the surface of submerged timbers. They begin to burrow inside, cutting off fine chips with the foot, possibly also by scraping with the valves. The burrow gradually grows in diameter and length, the siphon tips always at the small exit, the shells at the extreme end of the excavation. The burrow follows the grain where convenient, avoiding knots by changing direction, and turning aside usually for the burrows of others, though any burrowed wood specimen shows numerous exceptions to this rule.

The fine chips are swallowed and thrown out of the excurrent siphon, but this does not prove that they yield any sustenance to the mollusk. The large incurrent siphon, ciliated at the mouth, admits a steady stream of water charged with fresh air to bathe the gills; the lashing cilia drive in also minute organisms like infusorians which are passed into the stomach. This supply of food is quite sufficient. Moreover, the wood particles ejected seem only compressed, in no sense changed in composition or structure by digestive processes.

The *Teredo* breeds in spring. Millions of eggs are said to

be expelled by one female. The young are free-swimming for a week or two. When the size of a pinhead they settle on a floating tree or timber, tree roots, a ship's bottom, piles of bridges, or wharfing — any wood surface soaked in sea water is suitable to harbour them, provided it is not especially "medicated" to discourage their colonising it.

The tiny hole the *Teredo* makes to enter is never enlarged, though the burrow widens as it lengthens behind it. Only the slender tips of the siphons are extruded, imbibing and excreting organs. These are also sensitive tentacles. Back from their tips they are bound together, and two shelly valves, called pallets, or *claustra*, are hinged to the muscular wall. Pick up a bit of floating wood in New York harbour or elsewhere, and you are likely to cause a sparse fringe of colourless siphons to be suddenly retracted. The surface shows only inconspicuous pinholes. Cut into the wood, and it is honeycombed with tubes. Long, worm-like bodies inhabit shell-lined burrows. The pallets have sprung forward to cover the tips of the retracted siphons, and form a door barring the entrance effectually.

The pallets, by compressing and relaxing the walls of the siphons, help to pump water through the long canal. Perhaps they help to excavate the sides of the burrow after the foot had done the first hard digging. Possibly the valves of the shell assist. The problem is unsolved as yet. The shelly lining of the burrow is deposited by the mantle.

The shipping of the world has been at the mercy of this hardy little devastator, until metal sheathing and creosote oil were applied to submerged surfaces of wood. Uncounted methods were tried before success was reached. Ships' bottoms crumbled before a sign showed the timbers to be infested with the worm. Piles of bridges and wharves snapped below the water line for like reasons.

The ship worm does not like the taste of creosote, so painting with this, or better, soaking timbers in the oil or forcing it into the fibre by pressure, insures the preservation and defence of the wood against decay and ship worms. It is a double advantage to use it. Unprotected wood is rarely used in wharf and ship-building. Driving copper nails into timbers discourages the *Teredo*, but it is not a thorough method. There are still unguarded areas where rot and the borer may enter, and work at the heart.

The Ship Worm

In temperate waters *T. navalis* is about six inches long, when full grown. In the tropics it is often two feet long. Ordinarily the shell itself is never larger than a small hazel nut; the pallets grow to two inches in length. There is a related mollusk, *Kuphus arenarius*, Linn., living in sands in the Philippines, which has a tube two yards long, somewhat like the watering-pot's trumpet-like spout.

A boring isopod, *Limnoria lignorum*, shares with the *Teredo* the blame for destroying wood exposed to sea water. This creature actually swallows its chips. It subsists upon wood. *Teredo* feeds upon microscopic organisms taken through the incurrent siphon from the water. It asks lodging, but not board, too; so it asks less than *Limnoria* does.

A good word for *Teredo navalis*. It clears harbours of wooden debris; the hulks of derelicts, floating and sunken timbers, uprooted and drifting trees, all of them hidden dangers to navigation, until they crumble as the result of the perforation of their fibres by the ship worm. It is a scavenger of sea coasts.

CHAPTER IV: THE PIDDOCKS

FAMILY PHOLADIDÆ

SHELL bivalve, gaping at both ends; valves thin, white, hard, brittle, with rasp-like, overlapping laminations in front; hinge plate reflected over the umbones and a long curved, spoon-like process under each, for the attachment of muscles; accessory valves often present, external to the original shell; pallial sinus deep. Animal club-shaped; foot truncated in front; mantle closed, except pedal orifice; siphons large, long, united except near ciliated ends; branchial siphon (containing gills) closed throughout; hinge ligament strong, elastic, external.

A family of several genera of mollusks, living and fossil, which perforate rocks, clay or wood with vertical burrows, symmetrical and rarely in contact.

Genus PHOLAS, Linn.

Shell gaping, cylindrical; dorsal margin protected by two accessory valves, one anterior, one posterior; beaks covered; combined siphons form a large cylindrical tube, ciliated at end. Foot short, large. The property of shining in the dark is common to the whole genus.

These burrowing shell-fish have a brief infancy of freedom, then settle down for life in a cell dug by themselves in rock or clay, or wood. Granite is not too hard for some species. The burrow is made by constantly turning the shell about in its close quarters, so that the hard rasp-like surface grinds off the inner wall, the foot clasping the support by suction. At first, the entrance is made by rubbing the rock surface with sand particles grasped by the foot. There is no moving out for the piddock. He is safe and comfortable; food and oxygen are within reach of his long siphons; his chief enemies are starfish and crustaceans which tear or nip off the ends of his siphons before they can be withdrawn.

The Piddocks

Piddocks are eaten, pickled in vinegar, on the Normandy coast; they are also cooked with fine herbs and bread crumbs. They are collected for food and for bait near Dieppe by women and children who use a special iron pick.

The **Angel's Wings** (*P. costata*, Linn.) are found in colonies, ten inches to a foot deep in sandy mud in Florida; also in wood and rocks. They follow the coast northward to Cape Cod, but are rare above Cape Hatteras. The white valves conform strikingly in outline, colour and sculpture to the conventional representation of angels' wings. They meet only at a point near the tips. They are seven to eight inches long. The spoon-shaped processes inside the umbones serve as attachments for the visceral and pedal muscles.

This mollusk is a staple article of food in the markets of Havana. Its other name is the Ribbed Pholas.

The **Truncated Piddock** (*P. truncata*, Say) is short, pointed sharply at the posterior end of the shell, squared abruptly at the other. It is less than half the length of *P. costata*. The shell is rasp-like only at the pointed end. It burrows in mud or peat banks or in harder substances. Common on the whole east coast, companion of *P. costata* to its southernmost station; it is found also on the west coast of South America.

The **California Piddock** (*P. Californica*, Conr., *P. Pacifica*, Strns.) has three types of sculpturing on the three triangular areas of its surface; sufficient roughness to burrow in mud and stiff clay. The valves are white, thin and delicate, but partially covered with a horny epidermis. This piddock is cylindrical, and swollen to considerable width, especially in front. The posterior end is narrower and truncated abruptly. Length, $2\frac{1}{2}$ to 5 inches.

Habitat.—California.

Genus ZIRPHÆA, Leach

Shell oval, without accessory valves, beaks protected by a membrane; epidermis thin; anterior end gapes widely.

The **Rough Piddock** (*Z. crispata*, Linn.) has an oval outline, ending in a point at the anterior end. A furrow from the beak to the margin divides each valve into a smooth posterior and a ribbed and toothed anterior half. With this rasp-like surface the

mollusk grinds or scrapes its way into the stiffest clay, its favourite burrow. It is two to four inches long. It is found in California, New England and Europe.

Genus PHOLADIDEA, Turt.

Shell globose-oblong, with cross furrow, anterior gape large, closed, when mollusk is full grown, with callous plate; accessory plates minute. Animal with fringed disk at tip of siphons, and horny cup at their base.

The **Paper Piddock** (*P. papyracea*, Sol.) of Europe is the type. Thin as paper, yet it burrows into sandstone, hard clay, peat and buried wood along the Irish and Channel coasts. The basal cup seems to be a shield for the retracted siphon.

P. penita, Conr., occurs in soft rocks on the California and Oregon coasts. Its back is broad, the umbones covered with a round shield, in front of which lie the dorsal plates side by side. Two fin-like appendages proceed from and protect the base of the siphons. It is described as excellent eating. Length, 2 inches.

Some pholads burrow into oyster shells, some in hard timber, one in floating cakes of wax on the Cuban coast; an Australian species is found in resin; a fossil species resembles *Teredo* in lining its burrow with shell. A fresh water species works in wood several miles above the mouth of a Bornean river.

Genus XYLOPHAGA, Turt.

Shell globular, with cross furrows; gapes in front; is closed behind; burrow oval, with shelly lining; animal withdraws within shell, except siphons; foot thick, extensible.

The **Wood Piddock** (*X. dorsalis*, Turt.) of Europe and America, is a little nut-like mollusk, boring wood to the depth of an inch, and apparently eating the sawdust it makes. It always works across the grain. The boring instrument is the long elastic foot. The shell is covered with epidermis. Length, 1 inch.

This wood borer is in a sense a connecting link between *Pholas* and *Teredo*, at least as far as choice of material for burrowing goes.

Habitat.—North Atlantic Ocean.

CHAPTER V: THE RAZOR SHELLS. RAZOR CLAMS

FAMILY SOLENIDÆ

SHELLS elongated, open at ends; hinge terminal; ligament external; hinge teeth, two or three, compressed, posterior one forked; surface smooth, prismatic. Animal with powerful cylindrical foot; siphons short and united, or longer and separated at ends, gills narrow, extending into branchial siphon.

A family of agile bivalves which live buried vertically in sand.

Genus SOLEN, Linn.

Shell long, narrow, straight, with parallel margins; foot short, blunt; hinge teeth, one in each valve; mantle closed, except in front, forms siphonal sheath. World-wide genus, except in cold seas. Thirty-seven living species, forty fossil. Low water to one hundred fathoms.

The celerity with which these mollusks burrow to a level of safety in the sand is astonishing. Tread softly if you would find one at the mouth of his hole taking in fresh oxygen at low tide. Careless footsteps give the alarm. A jet of water flies up as the siphons are drawn in. The foot flies out, thin as a knife blade, cutting through the sand in a slanting downward course. Contracting this, a bulb is formed at the tip, which anchors it while the contraction pulls the shell down. The thrust and pull are repeated, and before you have begun to dig in the sand to discover him, the razor is safe with two feet of sand above him. The muscular strength of this mollusk is far greater, in proportion to size, than a man's.

English fishermen sprinkle salt on the mouth of the burrow of this clam, causing it to rise and spout to expel the irritant. It is popularly supposed that the razors hail it as a sign of the incoming tide — an unreasonable theory. Oil spread on the sand

calls the mollusks to the surface for air, and shows the fisherman exactly where they are.

Neapolitan fishermen wrap their toes in rags, go into water hip-deep, and explore the sandy bottom with the foot for razor clams. The mollusk is seized between the first and second toes. It is a well-trained foot that catches the agile razor in this way, and avoids ugly wounds from the thin shell blades.

The flesh of the razors is counted a delicacy along European coasts. We have not yet learned to appreciate the clear pink or yellowish white flesh, having never tasted it. We have not taken time to bother with small, thin clams, having larger, if coarser, kinds in plenty to supply us. The razor will come to popularity in due time. In flavour they are unsurpassed, and as they live in colonies, the digger who acquires a little skill will procure an abundant catch in a short time.

Razors have eyes like the scallops, ocelli or pigment spots, fringing the mantle edge around the siphons. By these they distinguish light from darkness. A shadow cast across the sand will cause the quick disappearance of every protruding siphon.

In water, razors swim about as scallops do, snapping their two valves together, and darting here and there with great suddenness and speed. A captured razor clam rapidly extends and retracts the foot, showing in pantomime how he burrows. Drop him on the sand and he goes down like a mole.

The **Sheath Razor Shell** (*S. vagina*, Linn.) largest of them all, has a straight cylindrical shell, squared at both ends. The extended siphon and foot make the shell seem inadequate to cover the body. A neck-like constriction grooves the anterior end. Length, 6 to 10 inches.

Habitat.— Europe.

The **Blunt Razor Shell** (*S. sicarius*, Gld.) is the common razor of the Pacific coast. It is four inches long, curved slightly, rounded behind, squared abruptly in front. Colour white, with glossy olive epidermis.

The **Rosy Razor Shell** (*S. rosaceus*, Cpr.) is a smooth, pinkish-white, flattened, straight tube. Its epidermis is olive and glossy. Length, 2 inches.

Habitat.— Southern California.

The Razor Shells. Razor Clams

S. viridis, Say, with pale green epidermis, two inches long, occurs north to Rhode Island and is abundant from New Jersey southward.

Genus *ENSIS*, Schum.

Shell elongated, transverse, curved or straight, gaping and squarish at ends; siphons short, divided; hinge teeth two and three at upper, anterior angle.

Very similar in structure to *Solen*, with which it is constantly confused. Fourteen species, in temperate and warm seas.

The **Sword Razor** (*Ensis directus*, Dall) is the common long razor of the east coast. The foot is thick and strong, and changes form with great suddenness, enabling the mollusk to disappear into the sand on the approach of danger. The valves curve slightly. The surface is marked longitudinally with fine growth lines, joined in the middle of each valve with cross lines concentric with the corner hinge. The white, thin shell is covered with glossy greenish epidermis.

This is *Solen ensis*, Linn., and *Ensis Americanus*, Gld. Length, 6 inches.

Habitat.—New England southward.

The **California Sword Razor** (*E. Californicus*, Dall) is a miniature of *E. directus*, delicate, slender, scarcely three inches long, and rosy-mottled on the cross lines, under the horny epidermis.

Habitat.—Monterey southward.

The **Pod Razor** (*E. siliqua*, Linn.) is the type. This is the "spout fish" of British coasts. It is curve but slightly and squared at both ends. The hinge at one corner has a single cardinal on the right valve fitting between two teeth on the left. The strong adductor muscles reinforce the hinge, else the valves would not be under control. Sand between mantle and shell cannot be expelled, so it is overlaid with nacre. This is the razor that snips off a portion of its foot when excited, the valves acting as scissors. Length, 6 to 8 inches.

Habitat — Europe.

Genus *SOLECURTUS*, Blainv. (*TAGELUS*, Gray)

Shell elongated, ventricose, smooth hinge sub-central; ends rounded, gaping; animal too large for its shell; foot thick; siphons



RAZOR CLAMS AND OTHER CLAMS

1 *Solen sicarius*.

2 *Platydor cancellatus*.

3 *Solen vagina*.

4 *Panobea Aldrovandri*.



Photograph by S. I. Carpenter

THE OLD CLAM DIGGER

separate; incurrent orifice fringed, excurrent plain; arc ventrical, cylindrical. Eleven species. Burrows below low water, deep in sand and mud.

The **Short Razor** (*S. gibbus*, Speng.) is a common mud burrower, south of Cape Cod, on the Atlantic coast. It has orange eye spots about the siphons to warn it of approaching harm. The exceeding length of its separated siphons, the tongue-like foot, and the yellowish epidermis, overhanging at the edges, distinguish this species. The burrow has two exits, one for each siphon. Length, 2 inches.

The **Californian Short Razor** (*S. Californianus*, Conr.) is abruptly rounded at each end. The shell has a dull epidermis, and a central hinge. Wild ducks and gulls have a great liking for this mollusk. They know where to find the colonies in the mud flats. Length, 3 to 4 inches.

Habitat.—Southern California.

Var. *subteres*, Conr., is more delicate throughout. Violet rays show under the olivaceous epidermis. This is found with the common form. Length, 2 to 3 inches.

Habitat.—Southern California.

CHAPTER VI: THE ROCK-BORERS

FAMILY SAXICAVIDÆ

Genus **SAXICAVA**, F. de B.

SHELL equivalve, thick, gaping at both ends; hinge with single cardinal tooth; ligament external, strong; animal symmetrical, elongated; foot finger-like; mantle, cavity closed, all but pedal opening; siphons large, long, covered with thick skin; orifices fringed. A small number of living forms; many fossil. Borers in sand, mud and soft rock.

The ways of this rock-borer are worth studying, for the mollusk is in the same class with the *Teredo*, as an undoer of man's work. The boring it does in cement work, in breakwaters and embankments, causes serious damage. The cells are large, often six inches deep, and later comers bore through into cells already completed, greatly weakening the structure. Each individual attaches itself to the wall of its cell by a byssal cord, and thrusting its siphons forth, settles down for life. The same cells are occupied by successive generations; the young attach themselves between the empty valves of parent shells. Thus several are found nested together in one cell.

The **Arctic Rock-borer** (*S. Arctica*, Linn.) is a representative of this family. It is found on cold New England coasts, boring soft limestone, and living in the cavities. It often burrows in mud or sand and affixes itself by a byssal cord to the root anchors of large seaweeds. It occurs also on the Pacific coast and in Northern Europe. It is largest in the coldest seas. Its shell is oblong, angular, wrinkled and harsh, with toothed laminations, fit instruments for rock-boring. The form on our east coast is less angular than the European, and larger. Length, $\frac{1}{2}$ to $1\frac{1}{2}$ inches. Small forms occur on the Pacific coast.

Genus **PANOPÆA**, Ménéard (**GLYCIMERIS**, Lam.)

Shell oblong, thick, equivalve, gaping widely at both ends, usually smooth, with epidermis; hinge near centre of dorsal



ROCK-BORERS AND HARD-SHELL CLAMS

- 1 Rayed Machera, *Machera Amboyana*.
- 2 Ridged Rock-borer, *Petricola costulata*.
- 3 Piddock-shaped Rock-borer, *Petricola pholadiformis*.

- 5 Nuttall's Hard-shell Clam, *Saxidomus Nuttallii*.
- 4, 6 East Coast Hard-shell Clam, or "Little Neck,"
Venus mercenaria.



SOFT-SHELL AND OTHER CLAMS

- 1 *Thracia Conradi*.
2 *Platydon cancellatus*.

- 3 *Anatina truncata*.
4 *Semele decisa*.
5 *Pandora trilineata*.

- 6 *Mya truncata*.
7 *Mya arenaria*.

margins a horn-like tooth and a socket on each valve; ligament external, conspicuous; siphons separate at tips.

Few species, including some clams of unusual size, widely distributed, chiefly in cold seas.

The **Norwegian Panopæa** (*P. Norwegica*, Spengl., *Glycimeris arcticus*, Lam.) is found off New England coasts and distributed by way of Arctic seas to Norway and Asia. Its trapezoid shell is thick, and each valve is divided into equal triangular thirds by two raised ribs that diverge from the hinge. The squared posterior end is broad, but scarcely more so than the great siphon tube that emerges, wearing its tough, dark skin in wrinkles until it is stretched at full length. In New England a good average of these shells is three inches long. In Norway they grow somewhat larger.

The **Giant Panopæa** (*P. generosa*, Gld.) lacks the posterior diverging ridge on the shell. It is the largest bivalve of the west coast. Six inches, the average length, is often greatly exceeded. The valves are flat, almost right-angled behind, rounded in front; distinct concentric growth lines mark the dull white exterior; the lining is pearly. The foot is small. The siphons are large and united, their chief protection a thick, wrinkled skin. The tube reaches a full yard in length with a thickness somewhat exceeding that of a stout broom handle. When disturbed the mollusk throws out a powerful jet of water, and retires to a depth discouraging to the collector.

"A truly noble bivalve!" is the characterisation applied by a conchologist who dug one out of the mud with the aid of two friends, one of whom had the arduous task of hanging on with a death grip to the great siphon, while he adjured his colleagues to dig for their lives, as his grip was likely to give out. This specimen weighed sixteen pounds. Dr. Stearns says: "The meat, when parboiled and fried in batter, is as tender as a humming bird's eye." The Indian name for this favourite clam is "Geoduck." It is found in Puget Sound.

Aldrovand's Panopæa (*P. Aldrovandi*, Lam.) of the Mediterranean is the giant of the genus. It is broad and deep, short and obliquely truncated in front. The lines of growth are uniform and distinct. Length, 10 inches.

The **Attenuated Panopæa** (*P. attenuata*, Sby.) from Port Natal, South Africa, long and narrow, is another giant.

CHAPTER VII: THE SOFT-SHELL CLAMS. SAND CLAMS

FAMILY MYIDÆ

SHELL strong, opaque, unequal, gaping; cartilage process flattened on left valve; ligament internal; epidermis wrinkled; mantle edges united except at pedal aperture; foot small; siphons long, united, retractile; gills two on each side, elongated.

Genus MYA, Linn.

Shell oblong, thin, soft, chalky; left valve smaller; gape at both ends; pallial sinus large; foot tongue-like; palpi free. Three living species; seventeen fossil in United States and Europe.

The **Soft-shell Clam** (*M. arenaria*, Linn.) is found on gravelly mud flats of river mouths from South Carolina to Greenland and Great Britain; by colonisation it has become established in San Francisco Bay. Its normal station is between high and low tide marks. Even rocky shores may harbour it, the mollusk burrowing in the sediment deposited in crevices. The animal lies head downward, its siphon tube extending upward into the water, if the tide is in; in any case, to the surface of the sand, or mud, to get a supply of food and oxygen. The limit of depth reached is about one foot.

Walk over the territory of the sand clam, at low tide, and little vertical spurts of water show where the siphons have been suddenly drawn down as a measure of safety. The length of the siphon exceeds that of the shell, which is as big as the palm of your hand. The mantle is prolonged into a tough protective sac to the fringed tips of the united siphons. A small hole at the opposite end gives egress to the pointed foot, the organ by which the mollusk travels through sand and mud.

Inferior to the quahog in popularity, the sand clam is, nevertheless, an important food mollusk. Up and down the Atlantic coast, in San Francisco and in British coast towns, the demand

for it is steady and large. It was the original basis of the famous Rhode Island clam chowders. In the fishing banks it is used, fresh and salted, for bait. In Greenland the walrus, Arctic fox and many birds are especially fond of it. The Pilgrims learned its value from the Indians. John Winthrop listed among the animals of Plymouth in 1634: "Clams—white. Their broth is most excellent in all intermitting fevers, consumption, etc. These clams feed only on sand."

The Indian name, "maninose," corrupted to "nannynose," is often used on the east coast. "Sand clam" and "soft-shell clam" are oftener heard. In English markets ask for "sand gaper" or "old maid," and you will get the familiar *Mya arenaria*.

The **Truncated Mya** (*M. truncata*, Linn.), with its posterior end abruptly squared, but otherwise agreeing with the characters of the better-known species, inhabits northern seas.

Habitat.—Puget Sound.

THE BROAD-TOOTH CLAM

Genus **PLATYODON**, Conr.

Shell unequal, gaping, squared at both ends, ventricose; hinge sub-central, with broad tooth; surface cross-striated and circled with growth lines; faint groove from apex to ventral margin; siphons united, closed by four hard plates.

The **Cross-barred Broad-tooth Clam** (*P. cancellatus*, Conr.) somewhat resembles the "soft-shell" of *Mya*. The white surface is checkered by fine intersecting ridges. Its hinge tooth is broad and spoon-shaped. The dilated, valved end of the siphon tube distinguishes it beyond question. The thickness of the shell and the bulging of the valves below the beaks are noticeable characters. Length, 2 to 3 inches.

Habitat.—California.

CHAPTER VIII: THE BASKET CLAMS

FAMILY CORBULIDÆ

Genus CORBULA, Brug.

SHELL small, thick, gaping in front, valves unequal, hinge formed by a recurved tooth fitting into a socket; animal unsymmetrical; mantle closed, except for the pedal aperture in front, with toothed edges; siphons united, short, fringed. An interesting group of small bivalves living in sand or mud.

The **Contracted Basket Clam** (*C. contracta*, Say) has its unequal swollen valves presenting an almost circular outline when seen end on, and drawn out to a truncated point at the posterior end. The surface bears regular small concentric ridges. Length, $\frac{1}{2}$ inch.

Habitat.—Cape Cod to West Indies.

C. nasuta, Say, is more nearly equivalve, pointed more sharply at the posterior end, but more nearly circular in the outline of each valve. Ridges fine and close. Length, $\frac{1}{3}$ inch.

Habitat.—Cape Hatteras to Haiti.

The **Yellow Basket Clam** (*C. luteola*, Cpr.) is shaped like the familiar little Donax. Its yellow shell shows faint lines of growth; the edges are thickened and turned inward. Length, $\frac{3}{8}$ inch.

Habitat.—Southern California.

The **British Basket Clam** (*C. gibba*, Olivi.) is swollen so out of symmetry that the right valve contains the body, and the left is like an operculum. The extended shell forms a protective roof for the siphons. The foot is tongue-like.

Cryptomya Californica, Conr., has thin, whitish, elliptical unequal shell, faintly checked with crossing striations, gaping behind; a peg and socket hinge; internal ligaments; the short siphons not covered with tough skin. Length, 1 inch.

Habitat.—California.

CHAPTER IX: THE DUCK-BILL SHELLS AND LANTERN SHELLS

FAMILY ANATINIDÆ

SHELLS thin, pearly within, granular outside; hinge toothless, pitted; ligament thin, external, with free ossicle; siphons long, united or free; mantle margins united; gills mostly single on each side; foot finger-like; palpi long, narrow.

A family represented as fossils in all the sedimentary rocks and all over the world, though nowhere very numerous. Tryon lists thirty-six genera. Of these over half are quite extinct, and those with living species form but a scant remnant of the family. Its highest development was reached during the Jurassic Period.

Genus ANATINA, Lam.

Shell thin, hyaline, silvery white, smooth, granular toward margins; constriction forms a neck below the posterior, beak-like extension which gapes widely to give exit to the united and sheathed siphon tube; hinge has spoon-like process in each valve; hinge ligament elastic.

An Oriental genus of thirty species named from a fanciful resemblance of the valve to a duck's bill.

The **Truncated Duck-bill Shell** (*A. truncata*, Lam.), abruptly squared at the posterior end, rounded in front, flattened and somewhat incurving on the margin opposite the hinge, is abundant in the Bay of Manila. It is about three inches long.

There is no American species of this genus.

THE LANTERN SHELLS

Genus PERIPLOMA, Schum.

Shell oval, valves very unequal, left valve deeper, posterior end contracted; lining pearly; hinge with narrow, oblique spoon-

The Duck-bill Shells and Lantern Shells

shaped process in each valve, usually a triangular ossicle between; siphons separate, long, slender. About a dozen species distributed on coasts of the western hemisphere.

The **Silvery Lantern Shell** (*P. planiscula*, Sby.) has a smooth, delicate white shell with a silvery lining. Its hinge is near the posterior end of the oblong valves which taper toward the rounded anterior end. Under each beak is a spoon-shaped, forward-turning internal hinge tooth. The left valve is flat, the right bulged. These are such fragile shells that waves which cast one on the beach usually ruin the shell as a specimen for the cabinet. Length, 1 to 2 inches.

Habitat.—Southern California.

The **Paper Lantern Shell** (*P. papyracea*, Say) is fragile, white and pearly, like its prototype on the west coast. It is rounded in outline, almost as broad as long, but tapering somewhat to the posterior end, the outline falling abruptly from the sub-central beak. The lines of growth and the groove from the beak are well marked. The surface is covered with minute wrinkles. The tooth is long, narrow, with an accessory process at the base. Length, $\frac{3}{4}$ inch.

Habitat.—Gulf of Mexico, Atlantic Coast. (Rare.)

Lea's Lantern Shell (*P. Leana*, Conr.) has a broad, regularly rounded outline, which slants away from the beak to the slightly narrow posterior end. It is fragile and white, with a diagonal ridge from the beak. Surface wrinkled, with an overhanging yellow, shining epidermis. Each hinge has a spoon-shaped internal process set almost horizontally and resting on an oblique rib. Length, $1\frac{1}{2}$ inches.

Habitat.—Northern Atlantic coast.

The **Round Lantern Shell** (*P. discus*, Strns.) is another of the fine species credited to the local collectors at Long Beach, Cal. For a time specimens were very rare. The valves are almost circular. The hinge line is approximately straight, and there is a truncated snout at the posterior dorsal corner. The thin, white valves are concentrically grooved. Length, 2 inches.

Habitat.—San Pedro, Cal.

Genus LYONSIA, Turt.

Shell sub-triangular, valves unequal, thin; hinge with narrow ledge in each valve containing ossicle and ligament; siphons short,

almost united, fringed; foot tongue-shaped, with byssal groove. Eighteen species, in all seas.

The **Californian Lyonsia** (*L. Californica*, Conr.) is narrowly oblong, with a straight hinge line, and prominent beaks nearer the posterior, swollen end. The anterior end tapers to a thin, crooked blade with a dorsal angle. The outer coat easily rubs off, showing the pearly inner layer. Length, 1 to $1\frac{1}{2}$ inches.

Habitat.—California.

The **Transparent Lyonsia** (*L. hyalina*, Conr.) has its pellucid shell prolonged backward and compressed; the beaks turn forward, over the rounded end. Distinct lines radiate from the beaks; these are crossed by concentric wrinkles. Length $\frac{2}{3}$ inch.

Habitat.—Whole Atlantic and Gulf coasts.

L. arenosa, Möll., is the size of a finger-nail, rounded at both extremities. It often has a film of sand on its opaque white surface. New England coast.

Genus THRACIA, Blainv.

Shell oblong, nearly equivalve, slightly compressed, drawn out and gaping over the separate siphons; surface smooth or minutely roughened, cartilage processes thick, external, with crescent-shaped ossicle; mantle closed; foot tongue-like; gill single, thick, plaited. Twenty species in northern and temperate seas.

The **Short Thracia** (*T. curta*, Conr.) is but little longer than broad, with fine wrinkles on the posterior areas of the valves. The hinge ligament is external, teeth small, pallial sinus shallow. Length, 1 to 2 inches.

Habitat.—California.

T. Conradi, Couth., is the giant of the genus, being as large as *Mya arenaria* — as the palm of one's hand. Almost as broad as long, the valves have sinuous margins, which fall away from the almost central beaks to a rounded front, and a truncated angular rear. A strong ridge sets apart the posterior area. The point of the left beak fits into a socket in the right. This thin-shelled mollusk occurs in deep water off the Massachusetts coast and northward, and also on the New Jersey coast and at Cape Hatteras.

T. synopsis, Beck, almost circular in outline, flat, its white valves engraved with close elevated growth lines, lacks the hinge cavity. Length, 1 inch. New England.

The Duck-bill Shells and Lantern Shells

The **Wavy Thracia** (*T. undulata*, Conr.) is a rare species, larger and thinner than *T. curta*. The wrinkles are wavy on the posterior area. The general form of the valves is circular, with central umbones. It is found on the west coast.

THE SEA BOTTLE SHELLS

Genus MYTILIMERIA, Conr.

Shell bivalve, rounded-oval, thin, fragile, usually inflated, with terminal spiral beaks, somewhat distant. Hinge without teeth; epidermis thin. Species few.

Nuttall's **Mytilimeria**, or **Sea Bottle Shell** (*M. Nuttalli*, Conr.), thin and fragile, is the type. The peculiarity of the whole genus is that the mollusks live together and make a common nest. This species nests among the colonies of sea-bottles, or compound ascidians. The delicate, white, bladder-like shell is protected by a brown epidermis, and by the ascidians which conceal it. Length, 1 inch.

Habitat.—California.

The **Rock-dwelling Mytilimeria** (*M. saxicola*, Baird) has a protean form, as it grows to fit the hole it enters. Pear-shaped when not crowded too much, the shell has a narrow and short anterior end; it is broadened, swollen and abruptly truncated at the posterior end. The brown epidermis is rough. The hinge plate, large, thick and concave, replaces an ossicle.

This is the mollusk, without a doubt, that Baird called *Lyon-sia*, and Keep calls by the sub-generic name *Entodesma*, Phil., the Rock *Entodesma*, *E. saxicola*, Baird. Length, 4 to 5 inches.

Habitat.—Puget Sound.

Genus PANDORA, Hwass

Shell unsymmetrical, right valve flat, left one convex, close shut, attenuated behind; two diverging grooves from apex of left valve. A small genus widely scattered, chiefly in cold waters. About twenty-five species.

The **Three-lined Pandora** (*P. trilineata*, Say) is a delicate little bivalve, in its pellucid white shell, too thin, almost, to cast a shadow. The lining of the shell is iridescent. Its hinge line

is concave, the other margins rounded. At the extreme posterior end the valves are spread apart to let the short, forked siphon tube through. The foot is finger-like. The muscles are weak, the body thin and inactive. The three lines are parallel with the margin, extending all the way around from the beak.

About Cape Cod this mollusk is plentiful. It frequents oyster beds and sandy or muddy bottoms, burrowing at varying depths. Length, 1 inch.

Habitat.— Maine to Florida.

CHAPTER X: THE SURF CLAMS. HEN CLAMS

FAMILY MACTRIDÆ

SHELL equivalve, three-cornered, heavy; hinge formed by two cardinal teeth with laterals; epidermis thick; siphon tubes united, fringed at tip; mantle open in front; foot flattened.

Genus MACTRA, Linn.

Shell thick, almost equilateral, anterior hinge tooth V-shaped. Widely distributed chiefly in tropical seas. One hundred and fifty species.

The surf clams live buried just below the surface of the sand. They extend the finger-like foot to a considerable distance in search of food; also use it in leaping. Star fishes and whelks are their enemies. They are eaten by man, and collected to feed pigs and to fertilise the soil.

The **Solid Surf Clam** (*M. solidissima*, Chemn.) is the common "hen clam" of the New England coast. It burrows in sand, from which it is dug at low water with shovels or clam rakes. Reeve says that at high water fishermen go out, poking the bottom with sharp sticks. If a stick by chance goes between the open valves of a clam, it closes at once, and the fisherman draws it up.

The shell is indeed *solidissima*. Lines of growth sculpture the surface. The posterior end is long drawn out. The hinge leans forward. The umbones are prominent. When open, the valves show at the hinge the very large heart-shaped cartilage pit, with long channels in both directions, and blade-like teeth with cross striations. The muscle scars are oval and very large.

This is the largest bivalve on our Atlantic coast. It is ponderous, too, but so muscular as to be able to leap, by means of its extensible foot, when escaping from enemies. Among these

are counted men, pigs, star fishes and whelks. Length, 7 inches.

The **Beaked Surf Clam** (*M. nasuta*, Gld.) is regularly elliptical, with a somewhat elevated beak on each side of the central hinge, and thin white valves. Length, 3 to 4 inches.

Habitat.—California.

The **Californian Surf Clam** (*M. Californica*, Conr.) looks like a little Mya, being thin-shelled, and flattened behind the central, furrowed beaks. Over the white surface is a yellow epidermis. Beaks very small, close. Length, 2 to 3 inches.

The **Mattock Surf Clam** (*M. dolabriiformis*, Conr.) has the form of an axe head, and is thin, flat, and white. Length, 3 inches.

Habitat.—San Diego southward.

M. lateralis, Say, is triangular and swollen, with a wavy and bluntly ridged posterior surface, and a ridge to balance it near the front. The prominent beaks are nearly central. Length, 1 inch.

Habitat.—Atlantic coast.

M. fragilis, Chemn., is a delicate shell recognisable by the darker colour of the epidermis covering the posterior area, which is set off by distinct ridges. Elsewhere the epidermis is yellowish. Faint rays extend from the central compressed umbones to the wrinkled margins opposite. Lining white, polished. Length, 3 to 4 inches.

Habitat.—North Carolina southward.

Genus LABIOSA, Schmidt

Shell oblong, thin, widely gaping and reflected posteriorly; hind margin defined by a thick lip or keel.

Sub-genus *Ræta* is a small group of surf clams with widely gaping, thick-lipped valves. A sharp ridge defines the posterior area. The valves are almost heart-shaped, thin, with concentric folds on the surface.

The **Channeled Ræta** (*L. canaliculata*, Say) has the characteristics above — it is the type. The grooves cut deep, making a very fragile shell; though much swollen in the front half, it becomes suddenly flattened behind. Interior grooved. Length, 2 to 3 inches; width, somewhat less.

Habitat.—New Jersey southward.

The Surf Clams. Hen Clams

L. lineata, Say, has a sharply keeled line setting off the anterior end, which gapes in a narrow line for the thin foot. The posterior gape is wider. The shell is white and very thin, closely marked with concentric lines. Length, 2 to 3 inches.

Habitat.—New Jersey southward.

Genus TRESUS, Gray

The **Washington Clam** (*T. Nuttallii*, Gray, *T. maximus* Midd., *Schizothærus Nuttallii*, Conr.) would doubtless, "by any other name" be still the giant of all the surf clams. Like many another of our molluscan giants, it is found on the Pacific coast. Tryon figures this shell as oblong, rounded at both ends. It is remarkable for the wide gape of its white valves at the posterior end, and the narrow gape in front. The body of the shell is much swollen, to accommodate the very large body. The blunt umbones come near meeting over the hinge, which has a deep, wide cartilage pit, and a long channel on each side of the cardinal teeth. A brownish epidermis covers the surface. This mollusk burrows deep in muddy bays. The laborious digger may need a helper to hold on to the clam's "neck" to insure its capture. He finds consolation in the fact that a large chowder may be made of a small number of clams. Dr. R. E. C. Stearns characterises this species as "a noble and estimable clam, which beats any other clam yet discovered for chowder, soup or pies." It has nearly the consistency of an oyster, a very small foot; the proportion of tough muscle is less than in *Mya arenaria*." Length, 6 inches. Puget Sound to Southern California.

Genus SPISULA, Gray

The **Dish Shell** (*S. catilliformis*, Conr.) is a fine large clam, with thin, smooth, white shell covered with a wrinkled, gray, horny epidermis. It has the characteristic Mactra shape, with sub-central, elevated beak. The hinge pit is triangular and very large. The pallial line reaches the middle of the shell. Length, 4 to 5 inches. Vancouver Island to Southern California.

Hemphill's Surf Clam (*S. Hemphillii*, Dall) grows even larger than the dish shells. It is a rare species, found at San Pedro and San Diego. A brown epidermis, much wrinkled at the posterior end, covers the white surface. Except for its



CLAMS, USEFUL AND BEAUTIFUL

- 1 An experienced clam digger wielding the rake.
- 2 Mud dug away to show hard-shell clams in place. Note tube where the siphon is thrust up to the surface.
- 3 Camp Venus Clam, *Circe castrensis*, showing variations.
- 4 Forking Venus Clam, *Circe divaricata*.
- 5 Elegant Venus Clam, *Dione Veneris*.
- 6 Frilled Venus Clam, *Chione Gnidia*.



CLAMS AND COCKLES

- | | | | |
|--------------------------|---|-------------------------------|----------------------------------|
| 1 <i>Tapes literata.</i> | 3 <i>Tivela crassatelloides</i> (much reduced). | 5 <i>Cyrena Carolinensis.</i> | 7 <i>Cardium quadrigenerium.</i> |
| 2 <i>Dosinia discus.</i> | 4 <i>Tapes staminea.</i> | 6 <i>Spharium sulcatum.</i> | 8 <i>Isocardia cor.</i> |

narrower anterior end and shallower pallial sinus, this might be mistaken for the preceding species. Length, 6 inches.

THE OTTER SHELLS

Genus LUTRARIA, Lam.

Shell oblong, gaping at both ends; cartilage plate prominent, triangular, with one or two small teeth anterior to it; pallial sinus deep, to accommodate the long, united, leathery coated siphon. Mantle closed except at opening for the protrusion of the strong foot; gills taper to mouth. Thirty-three species, living in sandy mud of quiet bays and in estuaries of rivers, burrowing vertically like *Mya*.

The **Oblong Otter Shell** (*L. oblonga*, Gmel) has the outline of a Hollander's wooden shoe, the beak at the ankle, the broad posterior end for the toe. Out of this the great siphon protrudes upward to clear water, while the foot ranges fifteen inches or more below in the sandy mud. The hinge is like a pivot and works in two planes: without parting the ventral lips of the shell the gape at either end may be closed. The foot extends out through the anterior end. The long side of the body is covered with a closed mantle.

Certain Channel Islanders laboriously dig these clams in shallow water, and use them for food. As shell fish they are known as "clumps." The shells are often five inches long.

Habitat.—Northern Europe.

CHAPTER XI: THE SEMELES

FAMILY SEMELIDÆ

SHELL thin, almost equivalve, gaping and usually flexuose behind; ligament external, short; cartilage in the cardinal pit; siphons long, divergent.

Genus SEMELE, Schum.

The **Rayed Semele** (*S. radiata*, Say) has flat, circular valves, a bit concave on the posterior side, colourless or rayed with bands of rose colour. Lining yellow. Length, 1 inch.

Habitat.—Georgia southward.

The **Rock Semele** (*S. rupium*, Sby.) with a pink hinge area, is a pretty species of Southern California. Length, 1 inch.

The **Clipped Semele** (*S. decisa*, Conr.) has its circular outline clipped behind in a straight line. The brown, wrinkled exterior is unattractive, but the shell lining is china-like, tinged purple, darkening to the lips. Length, 2 inches.

Habitat.—Southern California.

S. Californica, Ads., is a rare, yellow species an inch across. **S. rubro-picta**, Dall, has an irregularly cross-ridged surface rayed with purplish rosy bands. Inside, the thick valves are yellow or white. These two species are found in the same locality.

Habitat.—San Diego, Cal.

Genus CUMINGIA, Sby.

Shell ovate-triangular, broadly rounded in front, white, equilateral; surface marked with elevated growth lines.

C. tellenoides, Conr., ranges from Cape Cod to the West Indies. Specimens I studied alive at Woods Holl were taken from a thin stratum of soft mud in water three feet deep. The station of these interesting little clams is known only to Mr. George

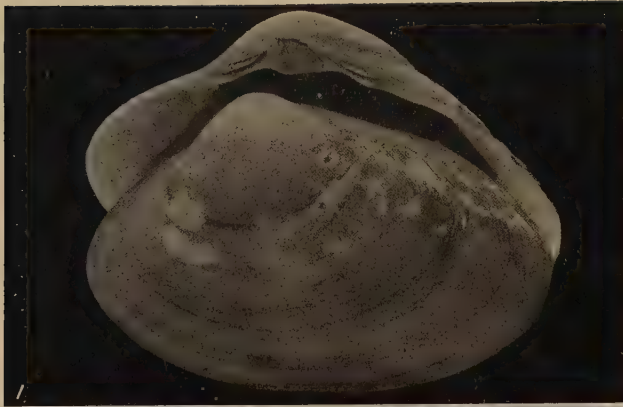


WEDGE SHELLS AND TELLENS

1 *Donax scortum*.
2 *Donax variabilis*.

3 *Macoma secta*.
4 *Macoma nasuta*.
5 *Tellinella rostrata*.

6 *Tellina discus*.
7 *Psammobia maxima*.



GIANT CLAMS AND SUNSET SHELLS

- 1 Surf Clam, *Mactra solidissima*.
- 2 Beaked Sunset Shell, *Tellina rostellum*.
- 3 Channeled Rata, *Rata canaliculata*.
- 4 Otter Shell, *Lutraria maxima*.
- 5 Rayed Sunset Shell, *Tellina radiata*.

Gray, the veteran collector for the Marine Biological Laboratory, who knows the sea bottom of that region, and the inhabitants thereof, as a cook knows her pantry shelves.

It was August, and the ventricose shells of the female were tinted pink by the mass of eggs under the transparent valves. In a dish of clear sea water the two siphons were soon thrust out at the pointed end of the shell. The broad foot steadied the valves on edge, while the siphons waved aimlessly up and down. They are like transparent, pink tubes, no larger when extended than a coarse thread. The upper, excurrent tube was two inches long when fully extended. The other was one-fourth as long. Eggs were discharged in a stream by the females. These were delicate, pink spherules, just visible to the unaided eye. Some shells were warped by growing in rock fissures. Length, $\frac{1}{2}$ inch.

C. Californica, Conr., twice as large, with ridged growth lines, represents the genus on the coast of Southern California.

Genus CERONIA, Gray

Shell ovate wedge-shaped, truncated behind.

C. Arctica, Conr., has thick, strong, smooth, sub-triangular valves, white under a yellow epidermis. The hinge has a V-shaped primary tooth with a long, striated lateral tooth on each side of it. Length, $1\frac{1}{2}$ inches.

Habitat.—New York Bay northward.

CHAPTER XII: THE TELLEN SHELLS. SUNSET SHELLS. WEDGE SHELLS

FAMILY TELLINIDÆ

SHELL free, compressed, usually equivalve and closed; texture translucent, porcellanous; hinge with two cardinal teeth; ligament external, on short end of shell; pallial sinus deep; foot flat, long, extensible; byssus wanting; mantle fringed, wide open in front; gills small, unequal, outer pair sometimes directed toward the hinge line; siphons long, slender, separate. A large family found just below the surface on sandy or muddy shores of all seas; a few in estuaries and rivers. It contains some of the handsomest of bivalve shells.

Genus TELLINA, Linn.

Shell rounded in front, angled and slightly folded posteriorly; hinge nearly central; valves slightly unequal, siphons twice length of shell; their tips not fringed; gills small, outer ones rudimentary, turned backward. Above three hundred species in all seas; centre of distribution, the Indian Ocean. Tropical species abundant, brilliantly coloured. One hundred and seventy fossil species.

The **Sunset Shell** (*T. radiata*, Linn.) also called the "sunrise shell," has its polished white valves painted with three broad divergent rays of pink, extending from beak to margin, in the same way that widening bands of light, glowing with warm colour, stream from the focus of the rising and the setting sun. There is a tinge of yellow about the hinge. In the curio stores on the Florida coasts, and in the West Indies these beautiful shells may be had for a very small price. If they were less abundant we would have to pay higher prices for them. The living mollusks burrow just below the surface, at low water, and anybody can get them by a little digging. The shells require no polishing, and those of our own digging have this advantage over bought speci-

mens: they are not faded by being exposed in sunny shop windows waiting for a buyer.

T. tenera, Say, has flat, fragile, pellucid white or rosy shells, covered with fine concentric lines of growth. The front is rounded; the posterior end slopes abruptly from the beak, forming a blunt-pointed extremity. Chief tooth in each valve grooved. This little mollusk frequents sandy beaches, just below low water mark. Length, $\frac{1}{2}$ to $\frac{3}{4}$ inch.

Habitat.—Nova Scotia to West Indies.

T. tenta, Say, is a little larger than *T. tenera*, has a dull white surface, and gapes at the narrow, posterior end.

Habitat.—Massachusetts to South Carolina.

T. alternata, Say, is a much larger clam, with flat, broad valves, scored with growth lines, every other one obsolete on the posterior area, which is set off by a straight angular ridge extending diagonally out from the beak. Colour, yellowish white or rosy. Length, 2 to 3 inches.

Habitat.—North Carolina to West Indies.

T. modesta, Verrill, is pinkish, white, or tinged with yellow, often in bands following the close lines of growth. The surface is polished, and iridescent. The beaks are small and set far back. A sharp angle subtends the flat, posterior area. The teeth of the hinge are strong, two-cleft. Length, 1 inch.

Habitat.—Puget Sound, New England.

T. polita, Say, is a shiny little white shell with minute concentric surface wrinkles. The umbones are nearly midway between the rounded front and the pointed posterior end of each valve. Length, $\frac{3}{4}$ inch.

Habitat.—North Carolina southward.

T. iris, Say, is a fragile, iridescent, white shell, with a few rosy rays and circles faintly colouring the valves. The margins are smooth and sharp; above, the surface is wrinkled and cross-ridged. Length $\frac{1}{2}$ inch.

Habitat.—North Carolina southward.

The **Leaf Tellina** (*T. foliacea*, Linn.) dull brown with scaly pointed posterior surface, is unlike other species. Though from the Moluccas and other remote islands, it is well known to collectors. Length, 4 to 5 inches.

The **Crested Tellina** (*T. cristata*, Recluz) has a solid, triangular shell, with a pointed ruffle like a cock's notched comb

all along the dorsal line. This is a rare white species, described by Reeve, who did not know where it came from.

T. elegans, Wood, resembles *T. radiata*, in its polished, pink-rayed shell, but it has greater depth and roundness in its ventral surface, and a peculiar "elegant twist" of the elongated shell.

Habitat.—Gulf of Mexico.

The **Rasp Tellina** (*T. scorbinata*, Linn.) is almost circular in outline, and the surface is covered with small, triangular, raised scales. The general colour is yellowish, painted with large regular spots of brown in a rayed arrangement. Diameter, 2 to 3 inches.

Habitat.—Society and Philippine Islands.

The **Purple Tellina** (*T. purpurescens*, Brod. and Sby.) is remarkable for the deep, rich rose-purple of the shell, inside and out. White, scaly granulations rise all over the surface; the dorsal margin has a white border. Length, 3 inches.

Habitat.—Central America.

The **Prince Tellina** (*T. princeps*, Hanley) is vividly red with white margins. The fine cancellations of the surface are not scaly nor white. Length, 4 inches.

Habitat.—Peru.

Ida's Tellen (*T. Idæ*, Dall) is a dainty white shell, with a distinctly ridged fold on each side of the hinge line, posterior to the umbo. The first known shell of this species was found on the beach at San Pedro in 1891, by Mrs. Ida Shepard Oldroyd, of Long Beach. Believing it to be new to scientists, she sent it to Dr. Dall at the United States National Museum at Washington. It was an "unknown." So a drawing and description of this new Tellen were published in the bulletin of the Museum. Dr. Dall named it in honour of the lady who found it. This is one of several species of west coast shells whose existence was first discovered by Mrs. Oldroyd.

The individual specimen upon which a new species is "erected" is called "the type." The original *T. Idæ* is the pattern with which all subsequent specimens must be compared. Though a rare species, collectors about Long Beach have found several of them.

The **Muddy Tellen** (*T. lutea*, Gray) is from the Behring Sea. Its oval shell is angled at the boundary of the posterior

area by a ridge running straight to the beak. Ridges radiate from the beak on the inside of the shell. Striations under the dirty epidermis sculpture the surface. Hinge ligament conspicuous. Length, 3 to 4 inches.

The **Salmon-coloured Tellen** (*T. salmonea*, Cpr.) is a notable shell because on the outside it is white or nearly so, and inside it is a rich salmon pink. The shell is thick, with glossy surface. It is rectangular, the beaks at one corner and the ligament at one end. Length, $\frac{1}{2}$ inch.

Habitat.— West coast.

A complete series of west coast Tellens would include, besides those described here, three or four species scarcely larger than a finger nail.

Genus **MACOMA**, Leach

Shell oval, or almost round, convex; cardinal teeth narrow; pallial sinus very deep. Gill with a single lamella on each side; palpi very large, triangular. Eighty-five living species.

The **Giant Macoma** (*M. secta*, Conr.) leads the whole genus in size. It will cover the palm of your hand. Note the flat, thin and glossy shell, inequivalve, and bare of epidermis except at the edges. The general shape is oval, with the posterior end somewhat contracted, set off by a fold, and ending in a truncated point. The broad ligament, which lies in a concave depression, is conspicuous on the hinge line, back of the beaks. Length, 2 to 3 inches.

Habitat.— Southern California.

The **Bent-nosed Macoma** (*M. nasuta*, Conr.) has the posterior end of its smooth white shell drawn out into a narrow extension, which is bent to one side. The mollusk lives in mud flats, burying itself deeply, but keeping the tips of its red siphons in the water above. This species is very much in evidence in the shell heaps about San Francisco Bay, which still mark the site of old Indian camping grounds. It was evidently the preferred shell fish in the bill of fare of the aborigines. The sand clam, *Mya arenaria*, an immigrant to these waters, seems to be replacing *M. nasuta* to a considerable extent. The shell mounds show not a specimen of this recent intruder. It is not easy to say why the Macoma is dying out. Length, about 2 inches.

Habitat.— Kamschatka to Mexico.

The **Little Macoma** (*M. Ballica*, Linn.) scarcely larger than one's thumb nail, with rounded outline, somewhat constricted posteriorly, is thin and pinkish or white. It is also a Californian species, but occurs abundantly on the whole Atlantic coast, and in Scotland and Norway. It is prolific in muddy and sandy bays, even following the banks of the Hudson River above the city of New York. It is protected by a thin, dingy epidermis. Length, 1 inch.

THE WEDGE SHELLS

Genus **DONAX**, Linn.

Shell wedge-shaped, triangular, ventricose, posterior end abruptly truncated just behind the hinge; anterior end prolonged and rounded; surface finely cancellated, the valve margins meet in fine interlocking teeth; hinge teeth, three in each valve, ligament external. Mantle fringed; siphons short, divergent; foot large, elastic, pointed.

A very distinct genus of small bivalve mollusks inhabiting sandy shores of warm seas.

The **Variable Wedge Shell** (*D. variabilis*, Say) is the prettiest and daintiest bivalve to be found in American waters. I have at hand in the original package the first dozen I ever saw, sent me from Florida packed in a skein of Sea Island cotton. They are like gay tropical butterflies, their flat, paired valves spreading like wings, exhibiting a range of colour that justifies the specific name. There are pinks and salmons, pale greens and yellows, lavender and fawn and white. Rays of colour from the beaks are crossed by narrow bands that centre there; the result is a plaid effect of unusual and attractive patterns. Their diminutive size make them seem more like jewels than shells.

The brightest of them fades when exposed to light. No cabinet specimen can compare with the living jewels that I found by thousands in the sand all along the Florida gulf coast. They sprinkled the yellow floor as each wave receded. But before I could pick up half a dozen they had gone. The pointed tongue thrust obliquely out and downward enters the wet sand, lifts the shell, and draws it under cover.

Floridians call them "pompano shells," and know them best as the basis of a most delicious soup. A sieve of suitable mesh is used to separate the shells from the sand in which they hide. It is not unusual to see women and children gathering the shells for use in the making of shell flowers and other articles which winter visitors buy. The valves are even punctured and strung, an inch or more apart, on coloured silk threads to be hung in doorways as *portières*. I saw one of these that was really exquisite; the colours blended as in a rich mosaic of small and uniform pattern; the dominant colour, a warm heliotrope, was furnished by the strong silk threads. A loose crocheted stitch hung each shell securely in its place. Not the least attractive feature of this unique, shining fabric was the very musical rattle it had whenever anyone brushed it in passing. Thirty dollars was paid for this piece of work which contained as many thousand shells. The largest was half an inch long.

The **Smooth Wedge Shell** (*D. lævigata*, Desh.) so strongly resembles its Floridian relative as to make a separate name seem unnecessary. White and shades of blue prevail as schemes of ornament, though lemon yellow and other colours are seen. Boys with push carts gather these miniature bivalves by the bushel at low tide, and sell them fresh to the townspeople at ten cents a quart. The broth is considered especially desirable for invalids.

Habitat.—Southern California.

The **California Wedge Shell** (*D. Californica*, Conr.) has the posterior end prolonged and rounded, so as to bring the two beaks near the middle of the shell. This is not the typical *Donax* form. The valves are extremely light and thin, and ordinarily lack the vivid colour that decorates the shells of the other two forms. Some have radiating stripes of blue or black.

Habitat.—California.

The **Hide Wedge Shell** (*D. scortum*, Linn.) is the largest species. Its valves are white and china-like, locking in front with strong teeth. The posterior end forms a heart-shaped concavity set off from the sides by sharp, angular ridges. The lines of growth are edged with upturning frills, and these are fluted by fine radiating ridges. Young shells wear rows of spines on the borders of the posterior area, and wide frills on the anterior end of the shell. Length, $2\frac{1}{2}$ inches.

Habitat.—Ceylon, Cape of Good Hope.

The Tellen Shells. Sunset Shells. Wedge Shells

The **Small-toothed Wedge Shell** (*D. denticulatus*, Linn.) is finely grooved from the beaks outward, and the ventral margins meet in a series of interlocking teeth. These are larger and thicker shells than the Floridian species. The posterior area is set off by two-angled ridges. The white surface is rayed with red, blue or orange. Length, 1 inch.

Habitat.— West Indies.

Genus HETERODONAX, Mörch

Heterodonax bimaculatus, d'Orb., is excluded from the proper wedge shells by its thin, oval form, and concentric ridges. It is like them in being many-coloured, in rays and stripes, purple, salmon and white. It is distinctly larger at San Diego than at San Pedro. The name calls attention to two distinct spots which are usually plainly seen. Length, less than 1 inch.

Habitat.— Southern California. Florida.

Genus PSAMMOBIA, Lam.

This genus is represented in California by *P. Californica*, Conr., a beautiful white porcellaneous shell rayed with red. It reaches five inches in length at Puget Sound.



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MARINE AND FRESH-WATER BIVALVE SHELLS

- | | | | |
|----|--|---|--|
| 48 | Rayed Scallop, <i>Pecten irradians</i> , Lam. | 52 | Painted Thorny Oyster, <i>Spondylus pictorum</i> , Chemn. |
| 49 | Fresh-water Mussel, <i>Unio lachrymosus</i> , Lea. | 53 | Rayed Tellen Shell, <i>Tellina virgata</i> , Linn. |
| 50 | Iceland Scallop, <i>Pecten Islandicus</i> , Chemn. | 54 | Fringed Pearl Oyster, <i>Avicula fimbriata</i> , Dkr. |
| 51 | Tulip Horse Mussel, <i>Modiola tulipa</i> , Lam. | 55 | Ass's-foot Thorny Oyster, <i>Spondylus Gaderopus</i> , Linn. |
| | 56 | Fresh-water Mussel, <i>Unio crassidens</i> , Lam. | |

CHAPTER XIII: THE ROCK-DWELLERS

FAMILY PETRICOLIDÆ

SHELL oval, thin, white, gaping behind; hinge with two or three teeth, no laterals; pallial sinus deep; epidermis thin; mantle thickened and recurved over shell at edge, closed in front, except for small pedal opening, foot narrow, pointed; siphons long, separate at least part way, tips fringed. Animal free, but frequently boring into clay and soft rocks.

Genus PETRICOLA, Lam.

Characters of the family.

The **Pholas-shaped Rock-dweller** (*P. Pholadiformis*, Lam.) is a narrow and oblique oval, with corner beaks, rayed faintly all over, wrinkled into ridges on the short anterior area. The long siphons are divergent for almost their entire length. The species is common on sandy or muddy beaches of New Jersey. Farther south it finds a suitable hiding place in masses of coral sediment. Length, $2\frac{1}{2}$ inches.

Habitat.— Atlantic coast.

P. carditoides, Conr., adapts its form to the burrow it inhabits. It often becomes very thick shelled and rough, and always dingy white. Preëmpting a suitable cranny when young, the shell grows to fit it. Length, 1 to 2 inches.

Habitat.— West coast.

Genus SAXIDOMUS, Conr.

Shell large, oval, thick, with three strong, divergent cardinal teeth in the hinge. Ligament large, external. Large edible clams of the northwest coast.

The **Giant Rock-dweller** (*S. giganteus*, Desh.) has the general form of the eastern hard-shell clam, but is larger, on an average. The extreme is between five and six inches in length.

The Rock-dwellers

This is the best edible clam at Vancouver. It is the "Oregon clam" of the Portland markets. The shell is chalky, with upturned, concentric ridges, dingy, or yellowish white. The lining is always white and china-like.

Habitat.—Aleutian Islands to Monterey Bay.

S. Nuttallii, Conr., is roughened by concentric ridges, and is coarse and dingy outside. Young ones have brown markings on the beaks, and purple stains inside the shell. Adults have a peculiar, clear, agate-like shell structure bordering the large, rubbery ligament. Length, 4 to 5 inches.

Habitat.—San Francisco to San Diego, Cal.

CHAPTER XIV: THE VENUS CLAMS AND CARPET SHELLS

FAMILY VENERIDÆ

SHELL sub-orbicular or oblong, regular, closed; ligament external; hinge with three divergent teeth; two muscle scars oval, polished; pallial line sinuate. Animal free, active, rarely burrowing, or forming a byssus for attachment; mantle with large anterior opening; siphons unequal, more or less united; foot tongue-like, compressed, rarely grooved; gills large, sub-quadrate, dorsally united.

Bivalves whose tropical forms are remarkable for elegance of shape, finish and coloration, frequently with chevron-shaped markings; texture very hard. A large family in tropical and temperate zones. The genera are variously arranged by authors who disagree.

Genus VENUS, Linn.

Shell thick, ovate, smooth, ridged or cancellated; margins minutely crenulated; cardinal teeth, three; ligament prominent, lunule distinct; mantle margin fringed; siphons unequal, separated; fringed, foot slim. A world wide genus.

The **Round Clam** or **Hard-shelled Clam** (*V. mercenaria*, Linn.) is the "Quahog" and "Little Neck," the chief commercial clam of our east coast. In Chapter I. of Part IV. this species is fully described as a typical bivalve. The obliquely round shells are familiar in the markets.

When the tide goes out the clam-digger may be seen in the mud flats and in shallow coves raking the clams to fill his boat or basket. He has a special tool called a "clam rake." It is not a romantic enterprise — "clamming" in the quagmires of Cape Cod or elsewhere, but it is profitable. The men usually wear high boots and do not mind wading in the clinging mud. Flat-bottomed boats are used in shallow water.

"Outside clams" with thinner shells, but of the same species,

The Venus Clams and Carpet Shells

are found on sandy bottoms of bays, or off exposed coasts. These are taken by rakes or by tongs such as oystermen use. The clammer goes out in a boat for them.

"Treading clams" is a method used in warm waters of the southern shores, where the gigantic variety, *Mortoni*, reaches six inches in diameter, and a weight of five pounds. The bare feet of the wading man range under the surface of the sandy mud, and rout out the individual clams one at a time.

The young clams of the typical species are almost as tender and fine flavoured as oysters. Adult specimens are tougher. Var. *Mortoni* is tough and coarse and too strong in flavour to be a popular shell fish except to people who have known no better clams. They are used extensively for chowders on the Florida coast.

The northern hard-shell reaches three inches in length and a width of two and a half inches. It ranges from Nova Scotia to the West Indies. The season lasts from April to September, coinciding with the oyster's closed season. Clams live a long time out of water, if kept cool, and are shipped in quantities in the shell to mid-continental cities.

V. Kennicottii, Dall, a lamellate clam resembling the quahog in size and form, is rarely found off the California coast and northward.

Sub-genus **CHIONE**, Megerle

The **Cross-barred Venus** (*V. cancellata*, Linn.) is one of the very abundant bivalves on the west coast of Florida. Narrow elevated ridges cross on the surface of the valves, which range in colour from white to cloudy yellow and brown. The white lining is tinged with violet. Length, 1 to 1½ inches.

Habitat.—Cape Hatteras to West Florida.

Chione includes also two or three compact little cross-barred clams on the west coast.

Genus **CYTHEREA**, Lam.

Shell ovate, smooth, thick; hinge with three cardinal teeth; siphons united half-way.

The **Japanese Cytherea** (*C. petechialis*, Lam.) is handsomely painted with brown chevrons and obscurely rayed on the neutral,

olive ground. Over the smooth, white shell substance is laid a shiny epidermis, like a coat of lacquer. It is brittle and, scaling off, removes all the colour. Length, 2 to 4 inches.

Habitat.— Japan Sea to Indian Ocean.

The **Convex Cytherea** (*C. convexa*, Say) is a smooth little round clam, with a convexity behind its prominent beaks. Length, 2 inches.

Habitat.— Nova Scotia to Cape Hatteras, west coast of Florida.

Sub-genus **CALLISTA**, Mörch

The **Giant Callista** (*C. gigantea*, Gmel.) is shaped and painted like a sunset shell, but the plaid pattern is oftenest developed in dull blue, lilac or gray, on a pale ground. A brown band of some width is set a little back from the margin. The hinge is nearer the anterior end. The posterior end is elongated, and pointed to a slight degree. The china-like shell is covered with a livid or pink epidermis. This species is especially abundant on the beaches of western Florida. Length, 5 to 6 inches; width, 3 inches.

Habitat.— Cape Hatteras to Texas.

The **Spotted Callista** (*C. maculata*, Linn.) is oval, ventricose, with a shiny surface, fawn-coloured, with broken radiating bands of violet-brown, and chevron prints in the spaces between the bands. A horny epidermis covers the shell. The flesh is edible as is also the giant *Callista*'s, but both have a peppery taste one must learn to like. Length, 4 inches; width, 3 inches.

Habitat.— Cape Hatteras to Texas.

Sub-genus **TIVELA**, Link.

The **Thick-shelled Tivela** (*C. crassatelloides*, Conr.) is one of the finest, as well as largest, of California clams. Walk along the beach at ebb tide, and you may see a depression like a thumb print, deep in the sand. Dig a few inches with a convenient shell scoop, and you reach the great three-angled clam, which reminds you of the surf clam, *Macra solidissima*, of the east coast. The thick valves are scored with growth lines, yellowish but painted with streaks or rays of purple and hints of red. The lips of the valves are thick and rounded. A single clam often weighs a pound.

I have never found these mollusks as abundant as I wished.

The Venus Clams and Carpet Shells

Yet a walk of half a mile on the sand at Long Beach often yielded five Tivelas, quite enough to make a royal chowder for a family of ten. In some places the farmers run ploughs through the beach sand, and turn clams out like potatoes in a field. They are often in the markets. Street venders sell them from push carts at five cents each. Length, 5 inches.

Habitat.—Southern California.

Sub-genus DIONE, Gray

Venus Dione (*C. Veneris*, Desh.) represents a beautiful group of Cythereas whose distribution centres in Australia. The rosy pink polished shell is a compact, ventricose little box, with the posterior area set off by abrupt angular ridges. These two ridges bear long, curving spines in two rows. The surface of the valves is scored concentrically and lamellar ridges rise between the sulci. The colour sometimes shades into deep violet. This is one of the most striking and handsome of bivalve shells. Length, 2 to 3 inches.

Habitat.—West Indies, Central America.

The **Orange Dione** (*C. aurantia*, Desh.) is a larger shell with bold ovate-globose form, the angled ridges spineless and scarcely showing at all. The smooth, polished surface is a rich orange colour. Length, 4 inches.

Habitat.—Eastern seas.

Sub-genus AMIANTIS, Cpr.

The **White Amiantis** (*C. callosa*, Conr.) is a pure white, oval shell, covered with concentric, lamellar ridges, often double. The hinge is set forward a trifle. Length, 3 to 4 inches.

Habitat.—California.

Shells of sub-genus *Circe* show beautiful chevron markings.

Genus DOSINIA, Scop.

Shell orbicular, compressed, concentrically lamellate or striated, a deep lunule under the small beaks; hinge teeth, three in each valve; ligament external, partly concealed; siphons united; mantle margins plaited; foot large, squarish.

The **Disk Dosinia** (*D. discus*, Rve.) is shaped like the discus

used in the Olympian games. The minute umbones top the circle with an acute point. The surface is finely scored with concentric lines. The epidermis is transparent and yellowish on the white valves. Diameter, 3 inches.

Habitat.—Virginia to West Indies, Texas.

D. elegans, Conr., has more pronounced and elevated ridges than its near relative. Otherwise they would be confused.

Habitat.—Cape Hatteras to Texas, West Indies.

The **Heavy Dosinia** (*D. ponderosa*, Gray) is yellowish-brown and smooth outside, except for fine growth lines. The deep lunule is cordate. The valves are white and thick, but the lips are thin as knife blades. Diameter, 4 inches.

Habitat.—Peru to San Pedro Bay, Cal.

THE GEM SHELLS

Genus GEMMA, Desh.

Shell minute, rounded or sub-triangular, equilateral; margins crenulated within; hinge short, narrow; muscle scars ventral pallia; sinus vertical. Very small clams abundant on the Atlantic coast.

G. gemma, Totten, about the size of a pea, with elevated beaks, and furrowed, violet-tinged white shell, is a well-known species. A colourless variety with beaks much elevated, abounds from Cape Cod to New York Bay. The gem shell of San Francisco Bay was introduced with seed oysters from Chesapeake Bay. *G. purpurea*, Lea, is the same species.

Habitat.—Labrador to Cape Hatteras.

THE CARPET SHELLS

Genus TAPES, Muhlf. (**PAPHIA**, Bolt.)

Shell transverse, ovate, inequilateral, margins entire; hinge three-toothed; siphons united to middle, divergent, incurrent tube with arborescent tentacular filaments; foot lanceolate, spinning a byssus.

The **Wavy Carpet Shell** (*T. fluctuosa*, Gld.) has a thin, pod-like shell, oval, with lamellate, concentric waves vanishing on the sides. A yellow epidermis overlies the white valves. Length scarcely an inch.

Habitat.—Newfoundland.

The **Ribbed Carpet Shell** (*T. staminea*, Conr.) is obliquely oval, radially ribbed, and brownish, often marked with chevrons of darker shade. It occurs all along the west coast, especially north of San Francisco. It is the "hard-shelled clam" of the markets. Length, $2\frac{1}{2}$ inches.

The **Netted Carpet Shell** (*T. laciniata*, Cpr.) is distinguished by the very fine criss-crossing of sharply chiselled lines on its valves. Prickles often stand at the intersections of these lines. The clam-digger takes these to market with the ribbed species; the two betray their hiding-places under the sand by jets of water that spurt up when the siphons are withdrawn by the startled clams. Length, 3 to 4 inches.

Habitat.—Southern California.

The **Finest Carpet Shell** (*T. tenerrima*, Cpr.) is so finely cancellated as to feel like a file. The shell is large, oval, with small beaks far forward, strong, divergent hinge teeth, and a long external ligament. The mollusk is somewhat rare. It has very long siphons, as the deep pallial sinus on each valve proves. It can go deeper than its kindred. The colour is brownish gray. Length, 5 inches.

Habitat.—West coast of United States.

THE ROCK VENUSES

Genus **VENERUPIS**, Lam. (**RUPELLARIA**, Fl. De Bellevue)

Shell bivalve, gaping, elongated; beaks well forward; posterior truncated; surface decorated with concentric, frill-like laminae. Thirty species. Mollusks live in holes in rocks, attached by byssus. They frequent temperate and cold seas.

The **Frilled Rock Venus** (*V. lamellifera*, Conr.) nestles among rocks on northern Pacific beaches. It is white with many thin, papery frills adorning the valve. Usually broader at the

posterior end, and truncated, yet it takes on many forms, to adapt itself to rock crevices. Length, 1 to 2 inches.

Habitat.— California northward.

The **Leafy Rock Venus** (*V. foliacea*, Desh.) is the most beautiful shell in the genus. The wavy frills are yellowish beneath and tinged with rosy violet toward the margins. Each frill turns a corner as it crosses a ridge running from the hinge to the sharply angular junction of the ventral and posterior margins. Under the laminæ faint radiating lines are seen in pairs. Length, 2 inches.

Habitat.— Mazatlan.

CHAPTER XV: THE CYRENAS AND PEA SHELLS

FAMILY CYRENIDÆ

SHELL equivalve, sub-triangular, small; hinge with two or three cardinals, and laterals; surface smooth, with periostracum; foot large, without byssus; siphons short. Sexes united in the individual; reproduction viviparous. Active bivalves, living in fresh or brackish water, believed to be derived from the marine family, Veneridæ.

Genus CYRENA, Lam.

The **Southern Cyrena** (*C. Carolinensis*, Bosc.) looks like a Mactra, but has two and three divergent cardinal teeth to form the hinge, with no pit such as the surf clams have. The smooth, ventricose valves are covered with a shining, brittle epidermis, usually rubbed off at the umbones. The beaks curl over the hinge line in quite pointed hooks.

These mollusks inhabit the muddy bottoms of brackish water on sub-tropical coasts. Length, 2 or 3 inches.

Habitat.— Georgia to Texas and West Indies.

Genus SPHÆRIUM, Scop.

Shell small, oval, oblique; hinge strong; siphons separate; foot mobile, used in climbing, and as a pond snail uses its foot in floating suspended at the surface of ponds. The clam also spins a mucus thread to travel on from place to place among stems of submerged water plants. The young remain in the brood pouch until able to take care of themselves; they are then shot out through the siphon.

The **Furrowed Sphere Shell** (*S. sulcatum*, Lam.) looks like a tiny model of a Venus clam, as it is obliquely oval with beaks well forward. The mollusk is found in still water, often climbing submerged plants, and waving its two siphon tubes while the

tongue-like foot slips in and out of the broad end of the shell. Length, $\frac{1}{2}$ inch.

Habitat.—River margins, ponds and lakes, Utah, California, Oregon.

Genus PISIDIUM, Pfr.

Shell somewhat pea-like in size and form, thin, smooth, with united siphons. Similar to *Sphærium*, but smaller; valves not so nearly equilateral. Habits similar.

The **Hidden Pea Shell** (*P. abditum*, Hald.) inhabits brooks and other fresh water, where it is difficult to discover, so well does its thin brown shell blend with its surroundings. Besides, it is scarcely larger than a grain of rice and may be easily mistaken for a seed of some water plant. It ranges widely, from New Mexico to the northwestern states. Modified forms have received varietal names, and many have been called new species. Several other pea shells occur in this country. There are several species in Europe. All are interesting tenants of the aquarium.

CHAPTER XVI: THE ICELAND CYPRINA

FAMILY CYPRINIDÆ

SHELL regular, equivalve, oval, valves solid; epidermis thick, dark; ligament prominent, outside; hinge with four large interlocking teeth; umbones oblique; muscle scars two, oval, polished; joined by pallial line; mantle united posteriorly to form two short ciliated siphons, elsewhere free; foot thick, tongue-like; gills unequal, two on each side. A small family of chiefly fossil species.

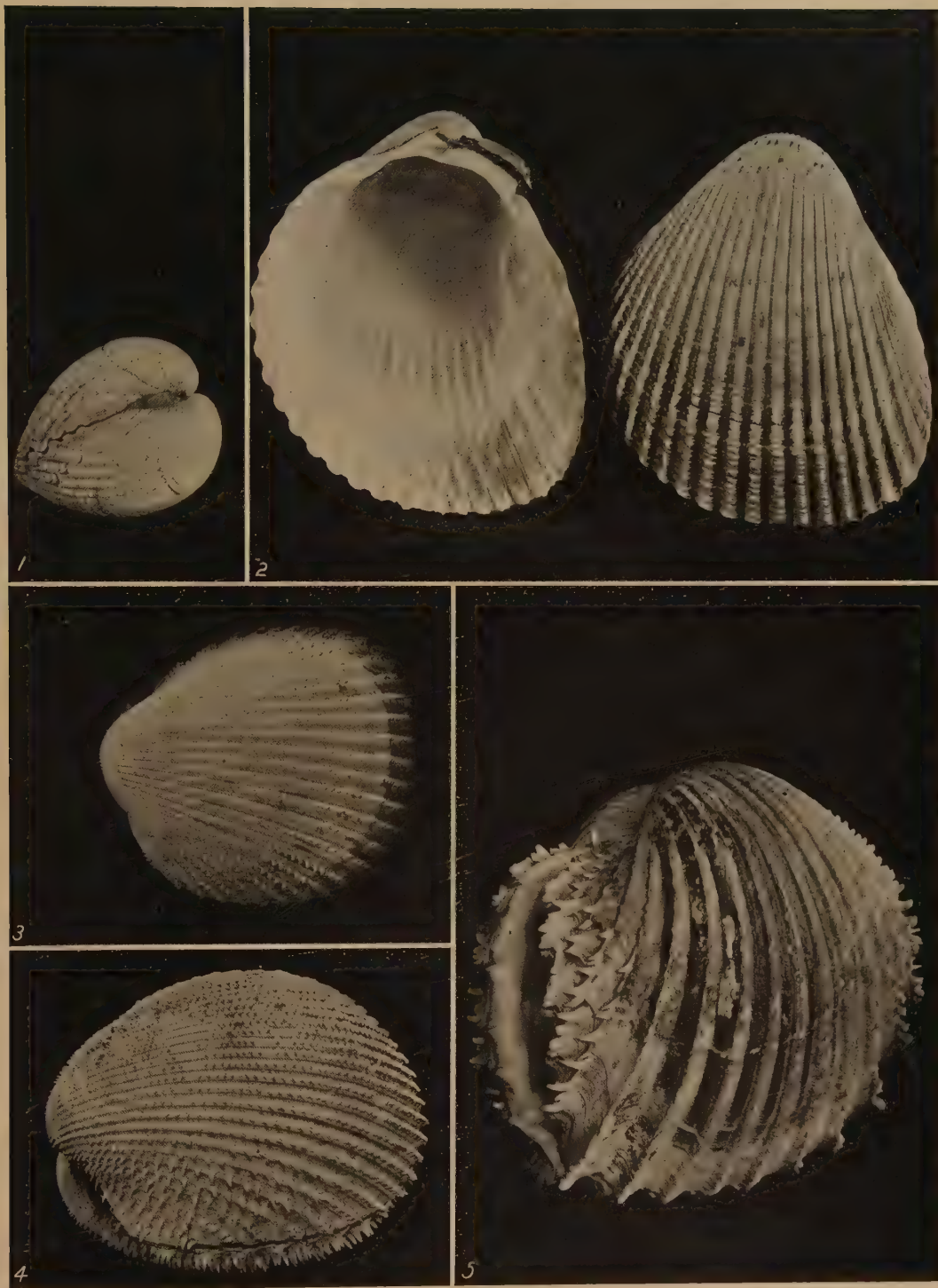
Genus CYPRINA, Lam.

Characters of the family.

The Iceland *Cyprina* (*C. Islandica*, Linn.) is our sole living representative of a family containing fossils of several genera and over one hundred species. It is found as a fossil in Sicily and Piedmont; living it ranges from the coasts of Norway and England to Labrador and south to Massachusetts. When alive the clam wears a shaggy coat of brown or black epidermis. It is like the quahog in general form, or a giant *Astarte*. It is found after storms on New England beaches. Length, 3 to 4 inches.

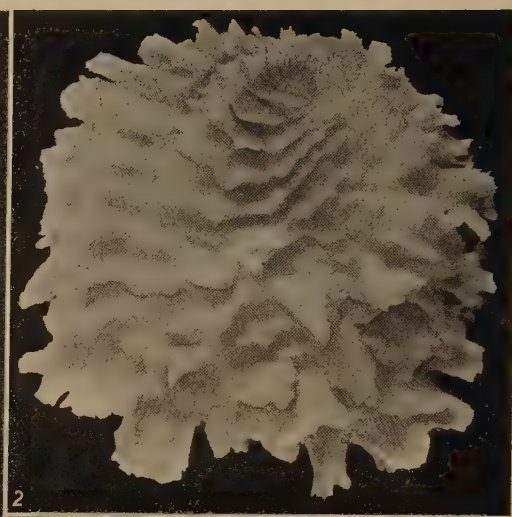
Another genus is represented by one of the handsomest of bivalve shells, *Isocardia vulgaris*, Rve., remarkable for the spiral development of its beaks.

Habitat.—China.



COCKLES

- | | | | |
|---|--|---|--|
| 1 | Edible Cockle, <i>Cardium edule</i> . | 3 | Great Cockle, <i>Cardium magnum</i> . |
| 2 | Prickly Cockle, <i>Cardium muricatum</i> . | 4 | Hedge-hog Cockle, <i>Cardium erinaceum</i> . |
| 5 | Ridged Cockle, <i>Cardium hians</i> . | | |



ROCK OYSTERS AND A SEA CLAM

- 1 2 White Rock Oyster, *Chama Lazarus*.
- 3 Chest Rock Oyster, *Chama arcinella*.
- 4 Leafy Rock Oyster, *Chama microphylla*.
- 5 Scaly Furbelowed Clam, *Tridacna squamosa*.

CHAPTER XVII: THE COCKLES. HEART SHELLS

FAMILY CARDIIDÆ

SHELL regularly equivalve, heart-shaped, radiately ribbed; sculpture of posterior area different from front and sides; hinge with one or two cardinal teeth and two laterals on each valve; ligament short, external; muscle scars squarish; pallial line sinuous behind; mantle open in front; ocelli on border; siphons short, fringed at tip; gills two on each side, thick, joined posteriorly; foot large, sickle-shaped, without byssus.

Free mollusks, marine or in brackish water.

Genus **CARDIUM**, Linn.

Shell globose, heart-shaped when viewed endwise; beaks prominent, nearly central; ribs strong; margins of valves crenulated. A large genus, one hundred species, of world-wide distribution, near low water, in sand or mud, forming extensive beds in sheltered bays or estuaries.

The **Common or Edible Cockle** (*C. edule*, Linn.) needs no description in Europe. It is so extensively "raked in" for food and bait from the sandy and muddy shallows skirting the British Isles and the Continent as to be the most familiar bivalve in fishing villages and in the city fish markets.

The solid shells bear about twenty-five strong, rounded ribs, with nodules or squamate scales, if the creature lives in muddy water; if in sand, these trimmings are worn off by attrition, as the mollusk moves about freely. Thrusting out the long foot to its full extent, the cockle lifts itself with a quick, twisting motion and flops a distance of several inches. The tip of the foot dilates, forming a fulcrum upon which the muscles act in this awkward mode of locomotion.

The foot is white, the mantle yellow, fringed at the border. A red band near the edge trims the yellow surface of the shells.

The Cockles. Heart Shells

All sorts of fancy articles, pincushions, purses, even shell flowers, are made of cockle shells. Length and width, 2 inches.

Habitat.—Europe.

The **Spiny Cockle** or **Red Nose** (*C. aculeatum*, Linn.) is a big, red mollusk in a spiny, broad-ribbed shell, yellow, tinged red. The bright red foot is long and pointed, which accounts for its name. Length and width, 3 inches.

Habitat.—Irish Channel.

The **Giant Cockle** (*C. lima*, Linn.) is as big as a cocoanut; the shell has a capacity of a quart or more. Its ventricose valves are scored with wide, shallow ditches between low flat ridges, smooth and polished, and pink shading darker toward the margins.

Habitat.—East coast of Africa.

The **Large Cockle** (*C. magnum*, Born.) is ours, and few cockles or other bivalves in the world excel it in size and beauty. It is roomy, somewhat oblique, and flattened posteriorly. Its ribs are close, deep, and flat, crenulated on the anterior area. The yellowish brown surface is painted with scattered spots of dark or purplish brown. The posterior area is uniformly dark. Ribs 35. Diameter 3 to 5 inches.

Habitat.—Virginia to West Indies and Texas.

C. isocardia, Linn., is obliquely oval, with recurved spines set on its deeply chiselled ribs. The anterior area shows larger, more blunt tubercles. The lips of the shell meet in fine scallops. Outside, the shell is yellow, stained with purplish brown. Inside it is salmon pink shading to purple. Diameter, 3 to 4 inches.

Habitat.—Cape Hatteras to West Florida.

C. muricatum, Linn., has a circular outline, and thirty-six ribs, all sharply cusped. The spines of the middle dozen ribs are directed toward some distant object, in quite the opposite quarter from the object at which all the other points have taken aim. This gives the species its chief distinction. The yellow-tinged surface is splotched with brown. The inner lip is orange. Diameter, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

Habitat.—North Carolina to West Indies.

The **Iceland Cockle** (*C. Islandicum*, Linn.) is obliquely roundish, thin, with thirty-six flat or spiny ribs, and a prominent, elevated hinge. A dark green or gray epidermis covers the pale shell. Length, 2 or 3 inches.

Habitat.—Arctic seas to Cape Cod.

C. pinnulatum, Conr., is small, thin, orbicular, with rounded ribs, creamy white, flamed with brown. This is an abundant species, and a favourite food of fishes. Fine specimens may be obtained from their stomachs, to say nothing of the rarer species often discovered there. The mollusk is very active, scurrying over gravelly bottom at a surprising rate by means of its extensible, recurved foot. Diameter, $\frac{1}{2}$ inch.

Habitat.— Labrador to New York.

The **Basket Cockle** (*C. corbis*, Mart.) is the most abundant and familiar cockle on the west coast. The end view is the exact outline of a St. Valentine heart. The beaks meet, the lips interlock their crenulated margins; the surfaces are finely striated across the close, rounded ribs. The shells are brittle, often broken when picked up on the beach. The mollusks are eaten, and are sufficiently abundant to appear in the markets north of California. Diameter, 3 to 4 inches.

Habitat.— Japan to Alaska, southward to San Diego, Cal.

C. Californiense, Desh., has very close, flat ribs, often so low that the furrows are but scratches on the surface. It ranges with the last species as far as Monterey. Several varieties occur farther north.

C. quadrigenarium, Conr., is the western counterpart of *C. magnum*. Its forty or more toothed ribs cover a capacious pair of valves. In early youth the shell is smooth. Colour dingy, with yellow teeth and lips. It is taken from deep water. Diameter, 4 to 5 inches.

Habitat.— Pacific coast.

The **Great Cockle** (*C. elatum*, Sby.) has a very ventricose strong shell with yellow shining surface scored with deep grooves. It is the largest of American cockles, attaining six inches in diameter.

Habitat.— Panama to Santa Barbara, Cal.

The **Ribbed Cockle** (*C. costatum*, Linn.) has scarcely a distinctive name in a genus where all shells are ribbed. This species shows an elegance of sculpture that is unexampled in the forms described above. The deep, grooved and ridged sulci are few, because they are so large; the sharp-edged ridges, similarly chiselled with secondary ridges, are few and well apart. The nine ribs converge in elevated beaks that meet over a straight hinge line. The shells are thin, almost translucent, the white surface

The Cockles. Heart Shells

bears a brown marginal band, and the sulci are brown. Length, 3 or 4 inches.

Habitat.—East coast of Africa.

Genus LIOCARDIUM, Swains.

Shell oval, elongated, oblique, inequilateral; surface smooth.

L. serratum, Linn., has only fine, concentric growth lines to roughen its smooth surface. The valves are deep, round saucers, thin as our grandmother's tea set, the white exterior tinged creamy by the rich yellow that lines it. Children playing at housekeeping on Florida beaches call these indispensable little shells, "buttercups." Diameter, 2 inches.

Habitat.—Cape Hatteras southward.

The **Egg Shell Cockle** (*L. substriatum*, Conr.) thin, showing only faint remnants of ribs, is splotched, especially within, with reddish brown, as certain birds' eggs are. The valves are circular with elevated beaks. Diameter, 1 to 1½ inches.

Habitat.—California.

Genus SERRIPES, Beck.

Shell subcordate, compressed, thin, almost equilateral; surface with obsolete, radiating ribs; beaks prominent; cardinal hinge teeth wanting.

S. Grœnlandicus, Chemn., has the generic characters. It is invested with a drab or olive epidermis. Length, 2 or 3 inches.

Habitat.—Maine northward, Alaska, Puget Sound.

CHAPTER XVIII: THE ROCK OYSTERS

FAMILY CHAMIDÆ

SHELL thick, roundish, irregular; valves unequal, ornamented with spines, scales or laminæ; beaks sub-spiral; hinge formed by a tooth fitting into a pit; ligament external; mantle closed, gills four, unequal; foot small; siphon small. Large part of family now extinct.

Genus CHAMA, Linn.

Characters of the family. Fifty species, attached to coral reefs in tropical seas. Depth fifty to a hundred fathoms. A few species found elsewhere. Forty fossil species in Cretaceous strata, Europe and United States.

The rock oysters cost all they are worth as an article of diet, for they grow fast to the natural masonry the coral polyp builds, wedged in crevices or attached to stones and shell masses on the ocean floor at considerable depths. They seem to choose most uncomfortable crannies, with no room to grow, and passively allow themselves to be walled in and smothered. Cramped by their habitation, their spines ground down by movable shells, often overgrown with seaweed and encrusted with sediment, all claims to beauty must be abandoned. Yet where they grow in favouring environment some rock oysters have high colouring and elaborate ornamentation of spines. Their parasitic habit costs them a high price.

The **Leafy Chama** (*C. Lazarus*, Linn) has broad, frond-like spines marking the lines of growth on its shells. It is white, tinted with rose. Each frond is delicately striated. This is found frequently in a perfect state. There is no handsomer Chama. Length, 2 to 3 inches.

Habitat.—Mauritius, Philippines.

The **Little Archer Chama** (*C. arcinella*, Linn.) is a cool water species, which, when it has a chance, develops a fine array of recurved spines. It is frequently attached to shells of the

fighting conch (*Strombus pugilis*). The area about the bases of the spines is peculiarly pitted. Yellowish or white, stained with pink. Lining usually orange. When grown together in a bunch these mollusks modify or lose their spinous ornamentation. Length, 2 inches.

Habitat.—North Carolina to West Indies.

The **Large-leaved Chama** (*C. macrophylla*, Chemn.) has a yellowish shell lined with white. Irregularly distributed are broad lamellar plates, like shingles, on both round valves. Pink and violet specimens are found. The edges of the lamellæ are crimped minutely. This species lives a moderately free life. Length, 1 to 2½ inches.

Habitat.—Tampa to West Indies.

The **Frondose Chama** (*C. frondosa*, Brod.) spreads over its purple surface a series of broad, fan-shaped laminæ, plaited and imbricated, not too closely nor irregularly, producing an effect of unusual richness. The colour is often brightened by yellow. This is one of the largest and handsomest species. Length, 2 to 3 inches.

Habitat.—Western Central America, Gulf of California.

The **Pretty Chama** (*C. pulchella*, Rve.) daintily ruffled, snow white, rayed with brown, and very compact of build, shows a peculiarity of the genus. There are rights and lefts, specimens showing opposite directions taken by the spiral beaks. This is a variation due to conditions of growth. Length, 1 to 2 inches.

Habitat.—New Holland.

C. gyrphoides, Linn., of the Mediterranean Sea, so deeply encrusts its thickly lamellate surface as to become very large and heavy — a shapeless mass of lime — where two or more are found together. Length, 3 to 4 inches.

The **Agate Chama** (*C. pellucida*, Sby.) has its rough exterior adorned by translucent frills, like rose agate or chalcedony. They grow fast to rocks or other submerged objects. You may find the upper valves on the beach. The china-white interior will show a daintily crenulated pallial border. Length, 2 inches.

Habitat.—Southern California.

C. exogyra, Conr., a left-handed species, rough, opaque and dirty white, occurs with its translucent relative, and looks very unattractive by comparison.

CHAPTER XIX: THE FURBELOWED CLAMS

FAMILY TRIDACNIDÆ

SHELLS equivalve, regular, truncated in front, very hard and heavy; ligament external; valves strongly ribbed from the hinge outward, ribs frilled, with wavy concentric laminæ; hinge with two interlocking teeth; mantle closed, but pedal opening large; foot finger-like, with byssal groove; shell muscle large, central.

Genus TRIDACNA, Brug.

The *Tridacnæ* or Furbelowed Clams, one of which, *T. gigas*, is the largest of all mollusks, live in beds of some extent in lagunes among coral reefs, among the islands of the Eastern and Pacific seas. The shell is generally white, sometimes tinged with red and saffron or brown-yellow, but the animal is brilliantly coloured. M. Quoy describes the beautiful iridescent glare of blue, violet, and yellow, variegated with fantastic markings, that is presented by these sub-marine parterres as seen through the clear blue water; and Mr. Cuming speaks with enthusiasm of passing over a mass of them nearly a mile in extent, which resembled nothing so much as a beautiful bed of tulips.—Reeve.

The **Scaly Tridacna** (*T. squamosa*, Lam.) has symmetrical valves, its rounded ribs adorned with erected frills "that are developed throughout with amplitude and precision." Fine cancellation adorns the grooves. The white substance of these massive shells is tinged or concentrically streaked outside with yellow or red. Diameter, 4 to 8 inches.

Habitat.—Moluccas.

The **Giant Tridacna** (*T. gigas*, Lam.) attains the enormous weight of six to seven hundredweight, its massive bulk measuring two to three feet across. One sees the single valves used as *benetiers* at the doors of Catholic churches. The animals inhabiting these gigantic shells weigh upward of twenty-five pounds, and are described as very good to eat. The natives of the Caroline Islands hew axe heads out of the thickest portions

The Furbelowed Clams

of these shells, whose hardness is remarkable. So far has the process of calcification proceeded that scarcely a trace of animal matter remains in an adult shell. Out of the open lunule (the depression in front of the hinge) the foot projects and from the gland a powerful tendinous byssal cord is spun. By this the mollusk is anchored to coral rocks.

T. gigas is distinguished at any stage of its growth by the four broad, main ribs, set with many close, short scales, which become still shorter as age advances. The shell veers obliquely forward in growth, which makes it unsymmetrical. The lining is tinged with rose. Diameter, 2 to 3 feet.

Habitat.—Indian and Pacific Oceans.

The **Serrated Tridacna** (*T. serrifera*, Lam.) has the symmetry of *T. squamosa*, and the few broad ribs of *T. gigas*; but the scales are reduced to lines of sharpened points following the ribs out but a short way from the umbones, and always more distinct on the anterior region. The whole surface is crossed by striations, radiating and concentric, which are stronger in the broad interstices than on the ridges. The white surface has a yellow tinge. Diameter, 3 to 4 inches.

Habitat.—Moluccas.

Three smaller species occur in the Philippines, all obliquely elongated, and well ruffled, so that one can know them at a glance as belonging to the genus.

THE BEAR'S PAW CLAM

Genus HIPPOPUS, Lam.

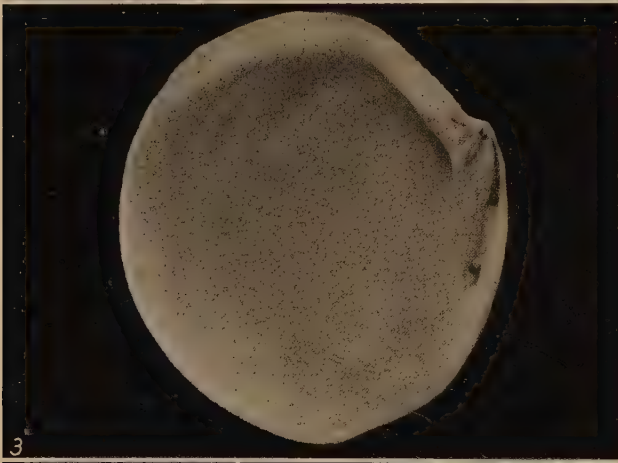
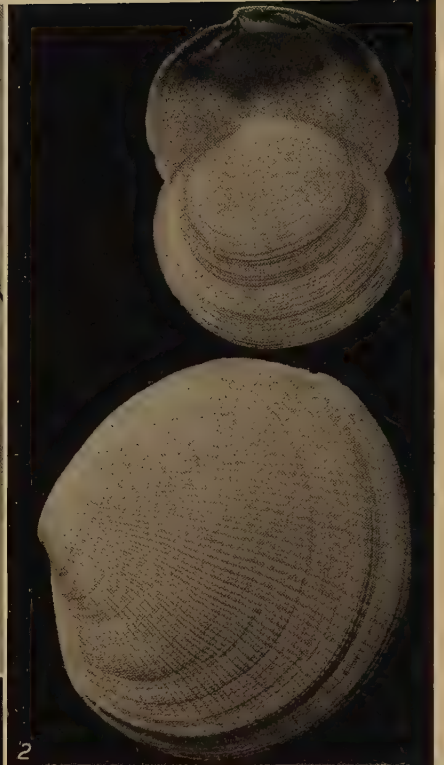
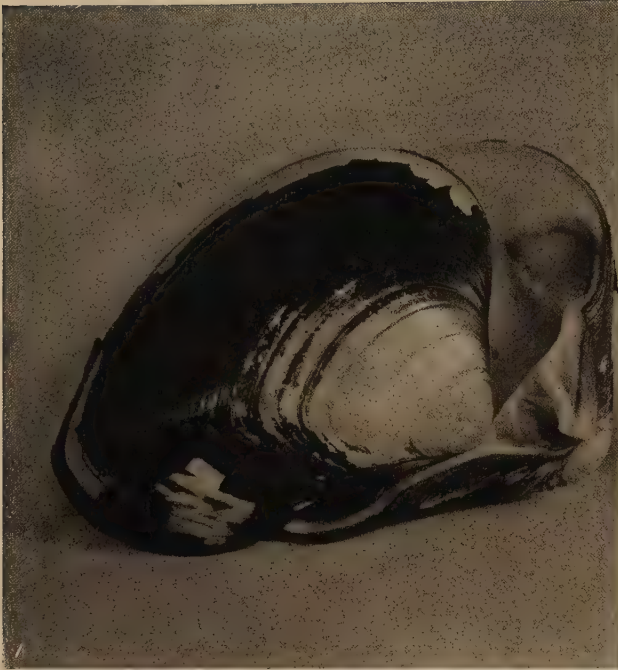
Shell massive, equivalve, regular; hinge with two teeth in each valve; lunule nearly closed; sculpture of elaborate frilled scales on its numerous ridges and interstices. Single species.

The **Spotted Bear's Paw Clam** (*H. maculatus*, Lam.) is one of the most elegant and highly prized of bivalve shells. Specimens are obtained in great abundance from eastern seas and distributed all over the world. Yet never a second species, nor even a distinct variety has been found, though the type species has been well known for nearly two centuries. The gracefully curved ridges and intervening sulci are adorned with rows of frond-like



1 One valve of the Giant Clam, *Tridacna gigas*, of Australia

2, 3 Bear's Paw Clam, *Hippopus maculatus*.



1 Chestnut Crassatella, *Crassatella castanea*.
2, 3 Tiger Lucina, *Lucina tigrina*.

4 Grooved Lucina, *Lucina Pennsylvanica*.
5 Northern Cardita, *Cardita borealis*.

6 Waved Astarte, *Astarte undata*.
7 Broad-ribbed Cardita, *Cardita laticostata*.

scales. The ivory whiteness of the ridges is varied by spots of rose purple arranged to form broken but concentric bands. The sulci are yellowish. The shell lining is pure white, with small marginal spots of rose.

The byssus is reduced to almost nothing, and the mollusk is free. It lives on coral reefs. Length, 5 to 7 inches. Width, 6 to 10 inches.

Habitat.— Eastern seas.

CHAPTER XX: THE LUCINAS

FAMILY LUCINIDÆ

SHELL circular, equivalve, with small, depressed beaks and distinct lunule; hinge teeth, cardinals two, laterals two, or toothless. Animal without siphons; foot very long, vermiform, hollow; two or four gills, often modified into brood chambers, their tissues occupied by eggs. A tropical family living in sandy mud, well represented on our own warm coasts by shells handsomely sculptured with ribs or lattice work.

Genus LUCINA, Brug.

Characters of the family.

The **Tiger Lucina** (*L. tigrina*, Linn.) has fine concentric ridges crossing paired ridges that radiate from the beaks. The valves are ventricose, solid and white. The long foot is folded upon itself and concealed between the gills. Diameter, 3 inches.

Habitat.—Florida to Texas.

The **Florida Lucina** (*L. Floridana*, Conr.) is an exceedingly abundant species on shallow, protected sand flats. The rough surface is dingy white, the growth lines yellow. The minute beaks point forward. Diameter, 1 inch.

Habitat.—West coast of Florida and Keys.

A deep water species, *L. filosa*, Stimps., is found all along our Atlantic coast. It is overlaid with elegant growth ridges. Diameter, 2 inches.

L. Pennsylvanica, Linn., wears a wrinkled epidermis which gives it a ribbed appearance and a yellow colour, though the valves are white, and ridged only on the large lunule. The distinguishing characters are the diagonal furrows which bound the posterior area, as angular ridges do in many species. Diameter, 2 inches.

Habitat.—Cape Hatteras, Florida coast, West Indies.

L. dentata, Wood, has oblique lineations on the concentric belts of surface separated by the remote growth lines. The margins are toothed. The beaks are elevated, central, often corroded. Diameter, 1 inch.

Habitat.—Cape Hatteras to deep water.

Nuttall's Lucina (*L. Nuttallii*, Conr.) exhibits a fine lattice work on its surface, and a flattened and ridged hinge line. Colour white. Diameter, 1 inch.

Habitat.—Southern California.

The **California Lucina** (*L. Californica*, Conr.) is an abundant little bivalve, circular, with fine concentric lines, and the lunule wholly on the right valve. The lateral hinge teeth are stronger than the cardinals, and the ligament is external. Diameter, $\frac{1}{2}$ to 1 $\frac{1}{2}$ inches.

Habitat.—California.

A deep water species of the northwest strongly resembles *L. filosa*, of the Atlantic side of the continent. It is **L. acutilineata**, Conr. Diameter, 2 $\frac{1}{2}$ inches.

Habitat.—Sitka to San Pedro Bay, Cal.

Professor Keep gives preference to the generic name, *Phacoides*, of Blainville, with *Lucina* as a synonym. *Lucina* is the more familiar name.

Genus LORIPES, Poli

This genus is represented on the Florida Keys and on our whole gulf coast by a deep water species, **L. edentula**, Linn., whose empty valves are cast ashore by storms. Cape Hatteras is its northern station. The large, circular valves are rather ventricose, finely scored by close growth lines, white outside and bright yellow within. The teeth and ligaments are very weak, and it is almost impossible to find mates among the hundreds of shells one has to choose from on the beaches of western Florida.

The children use these dainty little "buttercups" in setting the table in playhouses. The rich colour that rises almost to the rim suggests nothing more than melted butter. Diameter, 2 $\frac{1}{2}$ inches.

L. compressa, Dall, less than one-half inch long, somewhat

The Lucinas

oblong, with a straight, spinose dorsal margin, occurs in deep water of the Gulf of Mexico.

Genus SOLENOMYA, Lam.

Shell obliquely elongated, equivalve, resembling a razor clam; fingers of horny periostracum prolong the ribs of the shell considerably beyond its margin; ligament internal, hinge without teeth; mantle closed except where the siphon and foot emerge; foot snout-like, with a toothed disk at the end; siphon with two long tentacles at orifice. A single genus of few species in the family.

The **Little Solenomya** (*S. velum*, Say), unmistakable with its notched or fingered extension of horny epidermis over-reaching the plain shell margins, has broad, flat ridges radiating from its hinge at one corner of the oblong shell. Length scarcely an inch.

Habitat.— Nova Scotia to Cape Hatteras.

Johnson's Solenomya (*S. Johnsoni*, Dall) was dredged in water from one to two miles deep by collectors on the *Albatross*. It is a remarkable shell, with horny fingers equal in length to the width of the shell. This species has been taken at various points from Puget Sound southward. Length, 4 to 5 inches.

CHAPTER XXI: THE THICK-SHELLED HEARTS

FAMILY CRASSATELLIDÆ

SHELL bivalve, oblong, posterior end produced; sculpture consists of concentric grooves; epidermis thick; hinge with few cardinal teeth; pit on each valve.

Genus **CRASSATELLA**, Lam.

Shell with thick, solid valves, ventricose; ligament internal; lunule distinct; epidermis dense, brown. Chiefly distributed in tropical regions; but few fossils found in the United States.

The **West Indian Crassatella** (*C. Antillarum*, Rve.) has a three-cornered outline, though the angles are found only at the umbones and at the limits of the narrow posterior area. The ventral and anterior margins are rounded. The brown surface is regularly grooved. The lining is stained with chocolate, except at the borders. Length, 4 to 5 inches.

C. Floridana, Dall, replaces the last species from Cape Hatteras to Florida. Length, 2 to 3 inches.

The **Chestnut Crassatella** (*C. castanea*, Rve.) wears a bright horny coat of epidermis of a rich chestnut brown. It is characteristic of this covering to be worn off at the umbones, exposing the paler brown or white shell. Brown also stains the lining. The outline is oval, drawn out posteriorly a little. Length, 5 inches.

Habitat.—New Holland.

C. marginata, Cpr., yellow, with brown dots, or chevrons, and scarcely as large as a pea, is found on the coasts of southern California.

CHAPTER XXII: THE ASTARTES

FAMILY ASTARTIDÆ

SHELL equivalve, thick, triangular; surface ribbed; cardinal teeth two or three well developed; laterals obscure; ligament external, strong; pallial line entire.

Genus **ASTARTE**, J. Sby.

Shell heavy, sub-orbicular, closed, concentrically wrinkled or furrowed; epidermis thick; muscle scars two, kidney-shaped; foot tongue-shaped; mantle open; gills equal, oblique, united behind; siphonal orifices simple. About twenty species, burrowers in muddy shores of northern seas. Nearly three hundred fossil species.

The **Boreal Astarte** (*A. borealis*, Chemn.) is rounded in outline, barely wider than long, somewhat flattened, the umbones a little nearer the anterior end. The surface is irregularly grooved with rounded ridges, becoming smooth toward the margins. The white surface is covered with an epidermis of yellowish brown. Walruses rake these mollusks out of the mud with their tusks, and swallow them whole. Length, 1 inch or more.

Habitat.— New England to Arctic Ocean.

The **Chestnut Astarte** (*A. castanea*, Say) has its dorsal margin sloping up to the much elevated hinge, which, though almost median in position, yet turns decidedly forward. The concentric grooves are alternately strong and weak; a few faint radiating lines show through the chestnut-coloured epidermis. The animal's foot is bright red. Length and height, 1 inch.

Habitat.— New England to New Jersey, British Isles.

The **Flat Astarte** (*A. compressa*, Montagu) roundish, flattened, with beaks elevated, and fine lines becoming obsolete toward the margin, occurs from New England northward. Length, $\frac{3}{4}$ inch.

A. depressa, Brown, with its beak depressed, and valves convex, has its concentric ridges squared, and the grooves becoming obsolete on the umbones and near the posterior margin. Length, over 1 inch.

Habitat.— Maine northward, Arctic Seas of Europe.

The **Wavy Astarte** (*A. undata*, Gld., *A. sulcata*, Da C.) is a handsome, well-marked species, the concentric wavy ridges distant, the epidermis thick and brown. The blunt beaks are drawn forward and meet over the hinge line which is crenulated. Length, $1\frac{1}{2}$ inches.

Habitat.— New England to Cape Hatteras.

The western species range from Behring Sea to Puget Sound. All are small, roundish, with characteristic concentric furrows and elevated beaks.

The **Polar Astarte** (*A. polaris*, Dall) has a shining pale brown epidermis overlying a series of fine ridges. Length, $1\frac{1}{2}$ inches.

Habitat.— Alaska, Greenland.

The **Alaska Astarte** (*A. Alaskensis*, Dall) is white with black periostracum over coarse furrows. Length, 2 inches.

The **Esquimalt Astarte** (*A. Esquimalti*, Baird) has broad flat ridges that branch irregularly. Length, $\frac{3}{4}$ inch.

Habitat.— Puget Sound, northward.

The **Varnished Astarte** (*A. vermicosa*, Dall) has five ridges covered with a shining yellowish brown epidermis. Length, $\frac{3}{4}$ inch.

Habitat.— Behring Sea.

Genus CARDITA, Brug.

Shell round or oblong, radiately ribbed; margin toothed; hinge teeth two, strong, with an additional elongated posterior tooth. Mantle margins free except between siphonal orifices; incurrent tube with conspicuous fringe; foot rounded and grooved, spinning a byssus; gills rounded in front, tapering behind, united, outer pair narrowest.

The **Northern Cardita** (*C. borealis*, Conr.) is nearly round in outline, with broad, rounding ridges curving from the forward-pointing beaks. A rusty epidermis dips into the narrow sulci.

The Astartes

The inner margin of each valve is crenulated. Diameter, 1 to $1\frac{1}{2}$ inches.

Habitat.— New York northward.

Dr. Dall puts this into sub-genus *Venericardia*, a name that implies relationship with *Venus* and *Cardium*, and reports the species from the arctic seas to Cape Hatteras, in deep water. It is also found on the Pacific coast, from Alaska. Professor Keep describes a few closely related forms of *Venericardia*, all thick-shelled and from cold or very deep water.

CHAPTER XXIII: THE PEARLY FRESH-WATER MUSSELS

FAMILY UNIONIDÆ

SHELL equivalve, pearly, with thick periostracum; hinge variable, with or without teeth of schizodont type, all genera show at least vestiges of teeth arranged as pseudo-cardinals and laterals; beaks sculptured usually, often showing remains of nuclear shell, eroded when old, as a rule; pallial line usually simple; prismatic border narrow; sculpture variable. Animal with large foot; mantle borders free; gills four, leaf-like, dorsally attached; labial palpi four, wider than long. Embryo a glochidium, with bivalve shell, developed in the gills of the parent. Sexes united or separate. In higher forms, shell of the female swollen to accommodate the egg pouches, marsupia. Shells of thick pearl used in button-making. Pearls of considerable value are obtained from river clams.

A vast and complex family of fresh-water clams, inhabiting the sandy or muddy bottoms of streams and bodies of still water, Every continent has its own genera; every great drainage basin has its peculiar species. There is much variability within species.

Mr. Charles T. Simpson has published a "Synopsis of the Naiades" in Volume XXII., No. 1205, of the Proceedings of the United States National Museum, issued in 1900. Under the name, Naiades he groups the families Mutelidæ and Unionidæ. The latter only is represented in North America, though it is by no means restricted to this continent. The Mutelidæ include eleven genera, in tropical Africa and South America. The Unionidæ comprise sixty-one genera, with about one thousand species and eighty-two varieties. Of these over five hundred species and fifty-five varieties belong to North America. Others are distributed over the other continents.

Besides significant differences in the hinge teeth the two

grand divisions of the Naiades are based upon differences in the structure and development of the embryo, which widely separate the two families. The young of the Mutelidæ begin with a three-segmented body hatched from the egg, the central segment alone having a single shell. The Unionidæ hatch from the eggs as creatures with bivalve shells. This universal family trait deserves some definite description.

The gills of the parent clam are modified to form brood pouches which are swollen with eggs, and retain the young after they are hatched until they reach the stage called glochidium. The young are submerged during this waiting period in a nutritious mucus in the outer gill of the parent. A bivalve shell, loosely hinged, and joined by a muscular band, contains the soft parts, undifferentiated into organs until the mollusk is six months or a year old. Two strong, inward-pointing, saw-toothed hooks stand at the lips of the gaping valves. A thread-like byssus is coiled between them.

When the mucus is all absorbed the glochidia are discharged from the brood pouch into the water. On suitable bottom they lie on their backs with the byssal cords floating upward. Here each creature perishes unless a fish comes near enough for it to catch hold of with the prehensile cord. The successful individual is not slow to secure his hold by clamping the edge of a scale or a fleshy gill filament of the fish with the two hooks of the bivalve shell. A slimy exudation of the skin of the fish covers the minute clam that is catching a ride on fin or gill or elsewhere. The nutriment absorbed while thus encysted is sufficient to perfect the development of the vital organs. The young clam bursts the cyst, and falls to the bottom, where subsequent growth consists of gradual increase in size, through feeding upon microscopic organisms from the water.

Genus QUADRULA, Agassiz

Shell triangular, or quadrate, solid, swollen, with distinct posterior ridge crossed by irregular, coarse, concentric ridges, beaks prominent, with deep cavities inside; hinge plate heavy, wide, flattened; teeth ragged, solid, under beaks; laterals double, blade-like in left valve, single in right; epidermis dark, dull, sometimes feebly rayed; male and female shells alike. Inner gills



FRESH-WATER MUSSELS

- 1 *Trigonia margaritacea*. 2 *Anodonta marginata*. 3 *Lampsilis alatus*. 4 *Unio complanatus*. 5 *Unio litoralis*.



FRESH WATER MUSSELS

1 *Anodonta grandis*.

2 *Unio spinosa*.

3 *Tritigonia tuberculata*.

4 *Quadrula plicata*.

larger than outer pair; all occupied by marsupia in breeding time, forming smooth pads. Ninety-nine species.

The type described above is *Q. metanevra*, Raf. It occurs in the Mississippi drainage area except in its southern portion, and extends to the Tennessee and Arkansas rivers. It is one of the striking species. A row of nodules go down the posterior ridge.

Q. undulata, Barnes, has wavy radiating ridges from the beaks, forming sharp points. It is the "blue point" of the pearl button factories.

Habitat.—St. Lawrence basin, Red River of the North, Lake Winnepeg, Mississippi basin, Alabama River system, western and southwestern Texas.

Q. plicata, Say, is a handsome, ribbed species closely related to *undulata*. It is a "blue point."

Habitat.—Red River of the North, northward; Mississippi drainage to the Tennessee and Arkansas rivers.

Q. ebena, Lea, is a solid, rounded or ovate shell with black epidermis. The high beaks curve inward and forward over a distinct lunule. There is a feeble posterior ridge. The pearl is thick and white. This is the "niggerhead" used as the standard of value in the button industry.

Genus PLEUROBEMA, Agassiz

Shell solid, triangular to rhomboid, with prominent umbonal region. Beaks at or near anterior end of shell, incurved and pointing forward over a small lunule; beaks sculptured with a few irregular upturning ridges; posterior ridge low, rounded; epidermis showing plainly the different periods of growth, tawny or olive, with squarish spots forming rays; hinge strong, plate narrow, teeth triangular, ragged, laterals double; nacre silvery; shells alike. Animals yellow to salmon red, sometimes brown or blackish; marsupia occupying outer gills entire; ova sacs often paired. Seventy-two species. United States, chiefly in southern rivers.

P. Æsopus, Green, is the "bull-head" of the pearl button factory. The front part of the shell is very thick, the back part thin. The epidermis darkens with age.

Habitat.— Ohio, Cumberland and Tennessee river systems, west to Missouri and Minnesota.

Genus UNIO, Retzius

Shell oval to elongated, inequilateral, rounded in front, pointed or biangulate behind, with a posterior ridge, often arcuate when old; beaks not very full, sculptured with coarse ridges, doubly looped or broken; surface of valves smooth or concentrically ridged or pustulous; epidermis dull, sometimes faintly rayed; hinge plate narrow; teeth single in right valve, double opposite; cavity of beaks not deep nor compressed. Outer gills swollen into smooth pads when filled with young; gills attached their whole length to the mantle behind. Species 145, inhabiting all the northern hemisphere above the Tropic of Cancer, except the Pacific slope and Southeastern Asia.

U. pictorum, Linn., has its name from an ancient use to which the single valves were formerly put. They were used to hold artists' colours. Very common and easily obtained, shallow but stable, pearly lined—they served the painter's purpose exactly. Doubtless many artists keep to old traditions, scorning the newer porcelain utensils in the modern artist's "kit." The oblong, compressed valves with the low, eroded beaks well forward, have a thin epidermis, and concentric brown lines, the posterior area only rayed with green. The animal is red, with a broad, tongue-shaped foot used in burrowing into the mud. The mantle border is brownish, and united to form the two siphonal orifices.

The wide range of this species and the great amount of attention paid to its forms by conchologists of high and low degree account for the long list of synonyms in Mr. Simpson's report. Length, about 3 inches.

Habitat.— Europe and eastward, at least to the Lena River.

U. complanatus, Dillw., is the best known American species. It is elongately trapezoidal, scarcely inflated, nearly straight on the ventral margin, with small beaks depressed, well forward, and sculptured with a few coarse parallel lines. The shining epidermis is faintly rayed, but becomes roughened and the rays obsolete with age. Length, 3 to 4 inches.

Habitat.— River systems of the Atlantic region from St. Lawrence to Georgia, west in Canada to Manitoba.

U. spinosus, Lea, is an isolated species, distinguished by sharp thorn-like spines, one or two on each valve, near the beak. It is found in the Altamaha River, Georgia.

U. gibbosus, Barnes, is a mid-continental *Unio* of wide distribution. The shell is solid, triangularly or elongately ovate, arcuate when old, gibbous above, rounded in front, pointed or biangulate behind, with a moderate posterior ridge; beaks low, sculptured with a few strong, parallel ridges; epidermis cloth-like, dull; hinge teeth strong, rough; laterals club-shaped, vertically striated or granular; one or more furrows and ridges run parallel to laterals; muscle scars distinct, deep; mantle thin, with thickened edges; gills large, curved at ventral border. Several varieties are recognised. Length, 3 to 5 inches.

Habitat.— Entire drainage areas of St. Lawrence, Mississippi and Alabama Rivers; also to Guadalupe River, Texas, and into Florida.

Genus **ANODONTA**, Lam.

Shell thin, elliptical, often slightly winged posteriorly, inflated; beaks with fine parallel ridges, sometimes looped and nodulous; hinge toothless, reduced to a curved line; surface smooth, shining; pearl dull. Sexes with shells alike; marsupia filling whole of outer gills.

The **Swan Mussel** (*A. cygnea*, Linn.) is spread over Europe and Siberia. Its synonyms are legion, owing to its variability, and the tendency of "new school" conchologists to give slight variations the rank of specific characters.

A. grandis, Say, is a large and widely distributed American species. It inhabits the entire Mississippi system, the St. Lawrence and Red River of the North, Lake Winnipeg, Manitoba, extending to Southeastern Pennsylvania and into Texas.

A. marginata, Say, is a fragile, elongated *Anodonta*, with green epidermis, and bluish white lining, found in the St. Lawrence drainage.

Genus **LAMPSILIS**, Raf.

Shell oval or elliptical, usually smooth, without posterior ridge; epidermis shiny, often brilliantly rayed; two hinge teeth

with single lateral in right valve, two in left; female shell swollen in posterior ventral region to accommodate marsupia, which occupy the hinder part of outer gills; mantle margins doubled and thickened.

L. ventricosus, Barnes, with a thin, inflated shell, is the "pocket-book" clam of the button factories. It is the type species of the genus. Its range includes the drainage of the St. Lawrence and Mississippi rivers.

L. capax, Green, is another "pocket-book," obtained from the lower Ohio River drainage, north to eastern Iowa, southwest into Arkansas. It is locally abundant.

L. alatus, Say, has a strong dorsal wing set off by a ridge that runs backward from the beaks. It is a large species, with dark, cloth-like epidermis, and purple nacre. It inhabits the St. Lawrence and Mississippi river systems, and the Red River of the North. It reaches the Arkansas River.

L. ligamentinus, Lam., is the "Mouquet," "Mougat," or "Mucket," a fine button shell with silvery, sometimes pinkish, pearl lining.

L. anodontoides, Lea, is a solid, inflated shell, pointed behind, with a shiny yellow epidermis and lustrous white or purple nacre. It is the "yellow-back" or "yellow sand shell" used for buttons. It is found throughout the Mississippi and Gulf drainage.

Genus TRITIGONIA, Agassiz

Shell solid, elongately rhombic, with strong, irregular posterior ridge, obliquely truncated behind in the male shell, compressed and rounded in the female; surface covered with pustules.

T. tuberculata, Barnes, is the "deer-horn" or "buck-horn," the largest species that furnishes material for pearl buttons. The average "niggerhead," three or four inches long, cuts four or five "blanks"—disks that are ground down into buttons. A large deerhorn will cut four times as many, though not proportionately larger.

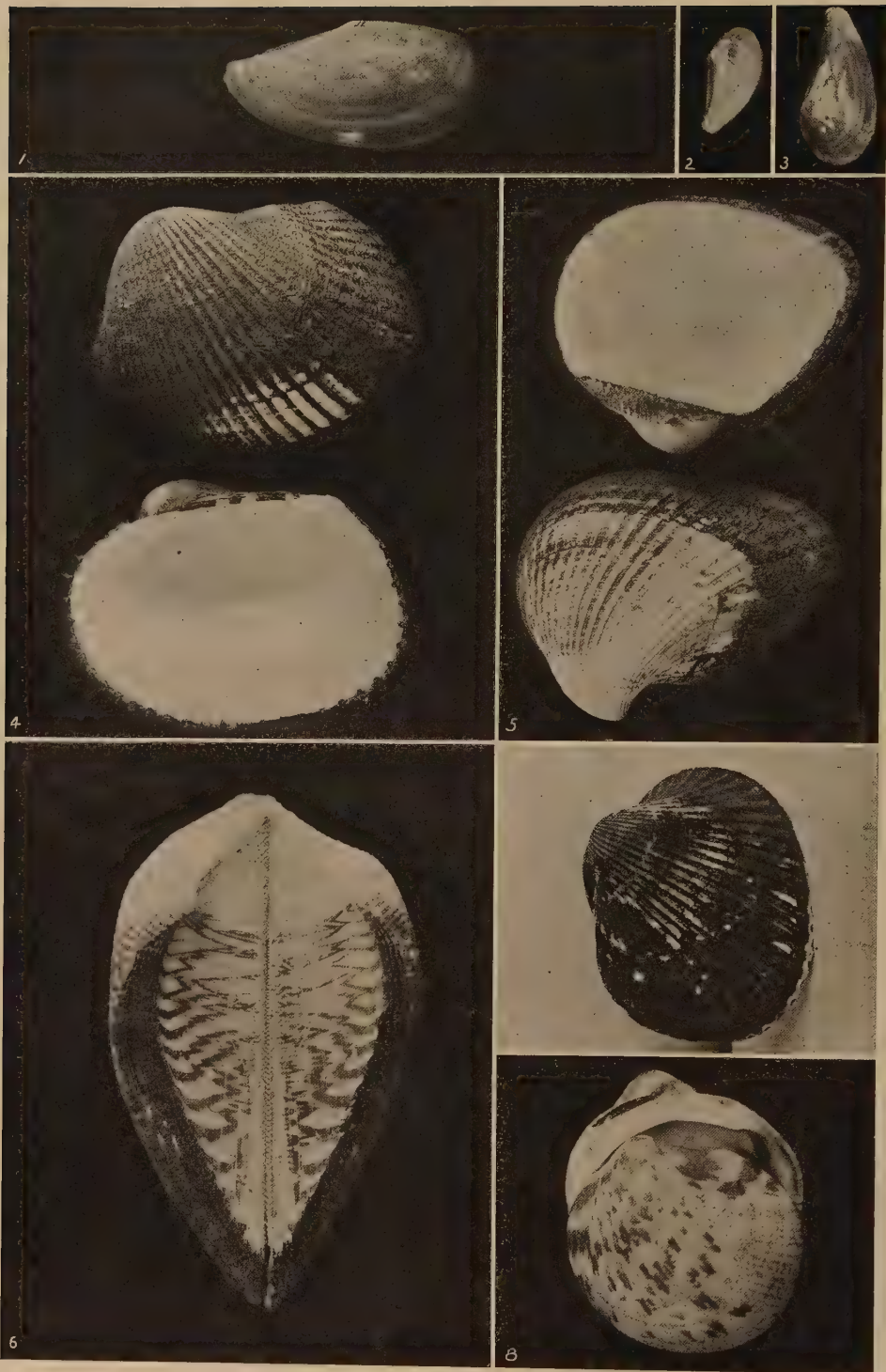
Habitat — Mississippi drainage and streams flowing to the Gulf from the Alabama River to Central Texas.



Photo by Automatic Button Company

MAKING PEARL BUTTONS AT MUSCATINE, IOWA

- 1 The shells of the river mussels are soaked a few days to toughen them.
- 2 Disks called "blanks" are cut by holding the shell in tongs against a circular saw.
- 3 In automatic machines the tops are cut and the holes are made.
- 4 The sorting of the polished buttons precedes sewing them on cards



ARK SHELLS AND OTHERS

- | | | | |
|-----------------------------|--------------------------|--------------------------|---------------------------------|
| 1 <i>Yoldia limulata.</i> | 3 <i>Leda pernula.</i> | 5 <i>Arca ponderosa.</i> | 7 <i>Arca pexata.</i> |
| 2 <i>Leda tenuisulcata.</i> | 4 <i>Arca Americana.</i> | 6 <i>Arca zebra.</i> | 8 <i>Pectunculus pennaceus.</i> |

CHAPTER XXIV: THE THREE-ANGLED CLAMS

FAMILY TRIGONIIDÆ

SHELL equivalve, closed, three-angled, with beaks pointing backward; ligament external; hinge teeth few, diverging; interior pearly; pallial line simple; mantle open; foot long, bent; gills, two pairs. Marine.

Genus TRIGONIA, Brug.

Characters of the family. The distinctions of this small genus of Australian bivalves are, (1) the brilliantly iridescent nacre that forms almost the whole of the shell substance; and, (2) the most closely interlocking hinge to be found among bivalves. The sheen of the pearl is sometimes golden, sometimes silvery; the ground colour is orange or deep rose-colour, according to the species. Diverging plates and grooves form comb-like hinge teeth before and behind the beaks. The outer surface of the shell is deeply scored with radiating grooves between rounded ridges, bearing nodose projections; the shell margin is crenulated; the gill margin frilled.

There are one hundred fossil species of this genus, found in the Devonian strata, all over the world. The three living species are confined to Australia.

The peculiar shell ornamentation found only in this genus of living mollusks occurs in fossil species of the fresh water Unios of Pliocene strata. This coincidence, with other structural similarities, leads Neumayr to believe that the great family of the Unionidæ is derived from Trigonina.

In the limestone quarries of Portland, England, the stone is often spoiled by the presence of "horse heads"—casts of Trigonina, silicified nodules which have gradually filled and replaced the shells, which are so largely of pearl that they gradually disintegrate. Casts showing in detail the structure of the soft parts have been found.

The Three-angled Clams

The activity of the animal is vouched for by Stutchbury, who, having dredged one in Sydney harbour, laid it on the gunwale of his boat, whence it leaped over a four-inch ledge and returned to its submarine abode. Strange migrations of these shell fish occur. All at once a region which has yielded abundantly will become absolutely barren of them.

The **Pearly Trigonia** (*T. margaritacea*, Lam.) is obliquely rounded in outline, and moderately convex, with ribs and nodules not very pronounced. It is the largest of living trigonias, and remarkable for its rosy purple pearl lining. Length, 2 inches.

Habitat.— Tasmania.

CHAPTER XXV: THE NUT SHELLS

FAMILY NUCULIDÆ

SHELL bivalve, three-cornered or oval, small, pearly inside; hinge formed of small, comb-like teeth, interrupted by a central pit for the ligament.

Genus **NUCULA**, Lam.

Shell with beaks turned toward the short posterior side; epidermis alive; hinge teeth sharp, comb-like; foot large, fissured, expanding into a fringed disk at tip; gills small, plume-like. About fifty species of small burrowing mollusks, chiefly in cold seas.

The **Thin Nut Shell** (*N. tenuis*, Montagu) is about as big as a grain of corn. Its smooth thin shells are protected by a bright green epidermis. This plain little shell is found northward from Maine and along all coasts of northern Europe.

N. proxima, Say, is a trifle larger, with an olive skin protecting the finely cancellated surface, and crinkled margins. This is the common little nut shell of the Atlantic coast to North Carolina. It occurs also in western Florida.

A few other species are found on our colder coasts.

The **Camp Nut Shell** (*N. castrensis* Hds.) is a triangular brown shell, with sculptured markings, like an array of tents, on the surfaces. Inside it is pearly. The valves are no larger than half of a navy bean.

Habitat.— Deep water, California to Alaska.

Genus **LEDA**, Schum.

Shell oblong, produced into an angle behind, usually rounded in front; margins not scalloped; hinge teeth as in *Nucula*; animal has two unequal siphon tubes, partly joined; mantle margins forming a third siphon in front; gills narrow, plume-like. About eighty species, widely distributed in cold seas.

The **Finely-grooved Leda** (*L. tenuisulcata*, Couth.) is drawn out, narrowed, and sharply keeled behind the umbones; it has a broad, rounded front. The surface is concentrically cut with fine lines, obscured in life by a thin, green epidermis. Length, 1 inch.

Habitat.—New England northward,

The **Hooked Leda** (*L. hamata*, Cpr.) a small flat shell, with its narrow posterior portion curved upward, is a deep sea form taken with a dredge near Santa Catalina Island. Its grooved sides are chestnut brown. Length, $\frac{1}{2}$ inch.

L. taphria, Dall, short-snouted, grooved and thick like a bean, 1 inch long, is found in San Pedro Bay.

Genus YOLDIA, Mörch

Shell thin, equivalve, polished outside, pearly within; dorsal line ends in angle behind; front rounded; valves flat; mollusks active; usually found in shallows of river mouths or lee shores.

Cooper's Yoldia (*Y. Cooperi*, Gabb) is a thin, close-ridged shell, with the hinge pointing backward and the sharp tip of the "tail" of the shell pointing upward. The comb-like hinge line bears about twelve teeth in front and forty or more behind the beaks. The ribs are concentric. This deep water species occurs off the coast of California, and attains a length of two or three inches.

Y. Montereyensis, Dall, a thin species with green epidermis and about twenty hinge teeth on each valve, is dredged from mud at the depth of half a mile in Monterey Bay. Length, $1\frac{1}{2}$ inches.

The **File Yoldia** (*Y. limatula*, Say) has a veritable file on the hinge line of each valve. The inconspicuous beaks are central; the valve rounds in front, narrows behind, ending in a sharp angle at the dorsal line. A glazed green epidermis covers the smooth surface.

The slender united siphon is thrust up into clear water from the mollusk's normal station just below the surface of the mud. The foot is extremely broad and highly developed as a burrowing organ. The thick, wedge-shaped extremity is thrust out obliquely at the front ventral margin, and when fully ex-

tended, dilated itself into two lateral flaps. Using this expanded disk as an anchor, the mollusk pulls the shell down toward it. Now the flaps close, forming a wedge-like cutting edge by which the mud is penetrated still deeper, and again the flaps dilate, and the shell is drawn down. In a second of time the *Yoldia* burrows several inches. Cormorants and flounders are its chief enemies. When out of its element the danger is greatest. On the sand *Yoldia* often leaps at surprising angles in a frantic attempt to get back to the mud covert. Length, 1 to 3 inches.

Habitat.— New England to Cape Hatteras, Norway, Pacific coast.

The **Broad *Yoldia*** (*Y. thraciæformis*, Storer) shaped like the blade of an axe, has a diagonal crease from the pointed beak to the ventral angle of the posterior margin of the shell. The surface is dark olive green. Length, $2\frac{1}{2}$ inches. Height, $1\frac{1}{2}$ inches.

Habitat.— New England coast.

Y. sapotilla, Gld., is like a half-grown *limatula* in outline, though narrowed less behind. The fragile valves are translucent, and coated with a glossy green epidermis. The lining is pearly white, with a triangular cartilage cavity, and nearly twenty sharp teeth on each side. Length, scarcely 1 inch.

Habitat.— Long Island northward, Alaska.

CHAPTER XXVI: THE ARK SHELLS. CHEST SHELLS

FAMILY ARCIDÆ

SHELL heavy, regular, box-like, with strong epidermis: ligament external; hinge with a series of comb-like teeth; mantle open; foot large, bent, and deeply grooved; gills oblique, united posteriorly to a web; ocelli in mantle margin; siphons wanting. Warm seas.

Genus ARCA, Linn.

Shells equivalve or nearly so, oval, or rather four-sided, strongly ribbed or cancellated, ventricose, covered with heavy epidermis; hinge straight, with many small, transverse teeth; beaks nearer anterior end of shell, separated by a wide, flat lozenge-shaped ligamental area; foot pointed, with a heel; mantle supplied with marginal ocelli; gills long, narrow; hearts two; blood red in some species; byssal gland wanting or well developed. About one hundred and fifty species distributed in all warm seas, from tide mark to 250 fathoms.

The **Bloody Clam** (*A. pexata*, Say) is well known because of its abundance and size, and the fact that it has red blood, a rarity among mollusks. The shell is solid, obliquely oval, with thirty or more ribs radiating from the hinge over the knob-like beak. The deep grooves are delicately cancellated. The epidermis is thick, dark and bristly. Inside the margin of each valve is a border of alternate ribs and grooves. The hinge has a comb-like series of teeth.

The bloody clam has no place among "economic mollusks," I believe. But the shells are important items in the equipment of the *littlest* children who spend happy hours building hills and valleys on the white beach sand. The concave of that strong scalloped shell makes of it a capacious scoop, and the curve of

its hump just fits the hand of the small architect. Height, 2 inches. Length, $2\frac{1}{2}$ to 3 inches. Rhode Island to Georgia.

The **Ponderous Ark** (*A. ponderosa*, Say) is exceptionally short and thick, in body and shell. The end view is symmetrically heart-shaped. The strong ribs are crossed on the marginal half by a few concentric lines, deeply impressed. The lips meet in a straight line. The beaks are distant, prominent and inclined to turn forward. The margins bear a wide border of dark, furry epidermis. Length, $2\frac{1}{2}$ inches. Fossil valves of this shell are picked up on New Jersey beaches.

Habitat.— Cape Cod to Texas, West Indies.

Noah's Ark (*A. Noæ*, Linn.) belongs to the group of ark shells which attach themselves by a byssus to rocks. For this reason they were called by Swainson, *Byssarca*, to distinguish them from the free-swimming species. These byssarcs throw out a glandular secretion, comparable to the horse mussel's tough rope, and the silken cables of Pinna. The byssus of the ark, however, hardens into a horny cone, made of thin plates. This the ark can cast off with great suddenness, and as promptly secrete another.

A Noah's ark is at best an irregular box. The prominent umbones are separated by a wide dorsal depression above the straight hinge line. They are near the anterior end of the shell, which slopes downward like the prow of a dug-out. A widening groove extends from the beak of each valve to the abruptly truncated rear margin. The hinge has about fifty fine teeth. The ventral margin gapes midway to let the byssus out. Farther back the white mantle edges are dotted with ocelli — eye-spots — small brown elevations, each made up of many facets. On one specimen of Noah's ark Patten counted 235 of these compound eyes, of varying sizes, in the two mantle borders. With these well-developed sight organs may be mentioned the presence of red blood.

The mollusk scrambles about in rock crevices, grubbing in crannies and among rubbish, and in its tender years the shell often gets "warped for life." The ornamentation, too, gets badly worn. Most specimens cast ashore are smooth, especially about the beaks. A perfect shell is covered with strong ribs, marked with tigerish streaks of brown and yellow. Inside, the colour is plain lavender. Length, 3 to 5 inches.

Habitat.— Mediterranean Sea, North Carolina to West Indies.

The Ark Shells. Chest Shells

A. Americana, Gray, has a larger, more oblong shell, with more ribs, flat and each impressed with a median line. These characters distinguish the two species, which occur together from North Carolina to the West Indies.

A. incongrua, Say, as broad as long, with wide ridges on the thin, unequal valves, is about two inches long and broad. The right valve is smaller, its ridges crinkled, especially behind the blunt umbones. North Carolina to West Indies.

A. transversa, Say, is rhomboidal in outline broadening at the posterior end. Its ribs are deeply cut, marked by fine scaly striæ, and crossed by a few deep, concentric lines. Epidermis brown. Length, $1\frac{1}{2}$ to 2 inches.

Habitat.—New England to Florida Keys.

The **Cross-lined Ark** (*A. reticulata*, Gmel.) a very small species with cancellated surface, is found on the beaches of southern California. Specimens of other Mexican species sometimes stray northward into these waters. Such visitants are rare. *A. reticulata* is found, also, from Cape Hatteras to the West Indies.

Genus PECTUNCULUS, Lam.

Shells orbicular in outline, with hinge teeth in a semicircle; ribs radiate, margins scalloped inside; animal with large, crescent-shaped foot, wavy-margined; mantle open, margins plain, with small ocelli; lips continuous with gills. About sixty living, eighty fossil species.

The **Feathered Pectunculus** (*P. pennaceus*, Lam.) white, mottled with brown, has its beaks meeting at one end of the ligament. It has the characteristic semi-circle of fine teeth locking the hinge. As in all ark shells, the number of teeth increases with the growth of the shell. Diameter, 2 inches,

Habitat.—North Carolina to West Indies.

The **Giant Pectunculus** (*P. giganteus*, Rve.) was used by western Indian tribes of tropical America for personal adornment. Their graves contain armlets, a favourite ornament, made by grinding away all but the rim of the shell. The beaks were cut into pendants, rings and beads perforated for necklaces. Bits were inlaid in mosaic work. In Arizona graves of prehistoric tribes are found clay images of the Pectunculus. The sea shells are evidently known, but rare, in a region far from their native sea.

CHAPTER XXVII: THE MUSSELS AND ROCK-EATERS

FAMILY MYTILIDÆ

SHELL equivalve, elongated or oval, beaks anterior ; hinge toothless ; ligament long, internal ; shell lining pearly ; periostracum thick, dark, often hairy. Mantle open except between siphonal openings ; four gills, elongated, leaf-like, attached to the mantle at their dorsal margins ; foot cylindrical, spinning byssus ; adductor muscles two, unequal.

A large family with abundant representation on all shores where they hang in masses on piers of wharfing, and cover submerged driftwood if it is lodged near the level of low water. Some are burrowers ; some spin nests out of bits of shells and sand held together by byssal threads. Some hide in the burrows of rock borers, or excavate soft rock to make their own retreats. They are economically important as edible shell fish and as bait for long-line fishing. The principal genera are represented in this country.

Genus MYTILUS, Linn.

Shell obliquely and narrowly fan-shaped, rounded behind, with terminal, pointed beaks in front. Mantle margins plain, projecting slightly behind ; incurrent tube of siphon fringed ; palpi long, pointed ; gills sub-equal ; flesh white ; byssal gland in "heel" of the small foot ; byssus strong, coarse. A world-wide, gregarious genus of sixty-five species.

The **Edible Mussel** (*M. edulis*, Linn.) native to the temperate shores of Europe, has proved a hardy immigrant to both our coasts. Acres of them are exposed to low tide on mud flats extending far up the estuaries of rivers that flow into the ocean. Again, we find them attached in masses to the rocks of exposed coasts, where the bottom is pebbly, and the water clear. A favourite station is the underpinning of wharves, in water befouled by contact with trafficking towns. Every outgoing tide

exposes the piers with their dingy incrustations of barnacles and black mussels of all sizes. Every fugitive timber, afloat or sunken, is coated. Vessels at anchor soon become loaded.

The young are numberless. At breeding time the mantle of the adult becomes transformed into brood chambers. The enormous development of the reproductive organs minimises all others. The minute yellow eggs seem to fill all the space between the valves. The "fry" settle upon any support that offers, to save themselves from suffocation in the soft mud.

We Americans do not eat mussels to any extent. They are in the fish markets because the foreign population demand them. In Europe they are rated a staple sea food, and consignments are shipped inland, as clams and oysters are in this country. In the Bay of Kiel it is a regular practice to put down branches of elm and other suitable trees. In a few years these boughs are taken up, laden with fine, large mussels.

Mussel-farming is carried on by the French who set tall stakes in the liquid mud with six feet exposed at low water. Basket work connects the stakes, and mussels cover the whole. They require less care than oysters, but are very sensitive to cold. Acres are sometimes killed by a single gale. As every yard of the basket-work, called *bouchots*, is calculated to yield a cartload of mussels, worth six francs, the profit of mussel culture can be guessed at. The most important "farm" has a total mussel-bearing surface amounting to somewhat over one hundred square miles.

The old tale that the Bideford bridge is held together by the network spun by mussels has a grain of truth in a husk of fable. It is true that the town council, believing that the masses of mussels protect the foundations from being undermined by the tide, has forbidden the taking of mussels from this place. Mussel beds in various places act as barriers, protecting lowlands from inundation. An artificial jetty is soon loaded with mussels and filled with silt, which year by year increase its stability and efficiency as a breakwater.

The Indians gathered mussels for food, and the colonists did likewise, but learned soon that clams and oysters were better food. The scow-loads of young mussels dredged or raked from beds along the coasts of New England and Long Island are sold to farmers who spread them as fertilizer on their fields. For



MUSSELS

- | | | |
|---|--|---|
| Edible Mussel, <i>Mytilus edulis</i> , showing
byssal threads by which the mollusk
clings to piles of wharves, etc. | 2 Hooked Mussel, <i>Mytilus hamatus</i> . | 4 Horse Mussel, <i>Modiola modiola</i> . |
| | 3 California Mussel, <i>Mytilus Californicus</i> . | 5 Ribbed Horse Mussel, <i>Modiola plicatula</i> . |



ACRES OF EDIBLE MUSSELS

Photograph by E. E. Soderholtz

the good of the oyster beds, it is well to keep the mussels in check. Thousands of bushels are taken yearly from the river mouths of Great Britain to supply bait for the long-line fisherman.

A tuft of coarse, black hairs attaches the mussel to its support. A word as to its origin and use will answer a very natural curiosity which the sight of it always arouses. Nobody would guess that it is an organ of locomotion, but that is precisely what it is. The foot is a weak and flabby string of muscle, with a gland at its base, which when compressed throws out a spray of gelatinous substance which hardens into threads so strong as to sustain a heavy weight. The mussel may wish to climb up a pier. It has only to eject more threads upon a spot higher up than its original point of attachment, and as these harden, let go the old threads and hang on by the new ones. Progress by this method may not constitute a gait more speedy than the minute hand of a clock makes, yet it accomplishes all the mussel requires. Time is no object to him. I have tracked an individual by a fringe of cast-off threads, but I have never timed one. Though able by this means to be a free and independent citizen, the mussel probably lingers near the place where it first settled down. It feeds like an oyster on what bounty the tides bring past the ciliated siphon tube. Bred in polluted water, it is often the carrier of disease germs when eaten. At spawning time it also causes sickness.

The shells are polished outside and made into needle-books, scent-bottle holders, pin-cushions, and various forms of jewelry, to sell to tourists and other souvenir hunters. The average shell is two or three inches long.

Habitat.—Europe. Arctic seas to Cape Hatteras, Pacific coast.

A variety, *pellucidus*, brightly rayed with green and yellow is often found with the typical form on our east coast. Another, var. *glomeratus*, thrives in San Francisco Bay. It is two inches long, and is constantly found in the fish markets of the city.

M. Californianus, Conr., is pictured by Reeve as a deeply grooved and rayed green and yellow shell when young, but at maturity a blue-black giant, rough, without stripes, and eight or nine inches long. It averages much smaller, and is brownish or purple, with orange flesh. The Californian Indians set sharpened points of this hard mussel shell in the tips of their harpoons.

The **Hooked Mussel** (*M. hamatus*, Say) is a thick-shelled species with fine, crooked ridges, and a twisted, beak-like hook at the hinge end. Large clumps of the young are often found attached to oysters. It is dark drab or brown. Abundant in Florida. Length, 1 to 2 inches.

Habitat.—Chesapeake Bay southward, Gulf coast.

THE HORSE MUSSELS

Genus **MODIOLA**, Lam.

Shell cylindrically oblong, inflated in front, with beaks small, rounded, almost, but not quite terminal; epidermis often produced into a beard-like fringe; byssus ample, fine. Animal as in *Mytilus*; flesh orange or red.

A widespread genus of seventy species, chiefly tropical, includes the nest-builders of the family. Some cling in masses, as *Mytilus* does. The coarseness of the flesh and its unfitness for human food are indicated by the name.

The **Common Horse Mussel** (*M. Modiola*, Linn.) is like the edible mussel in outline, but the shell is much swollen, and the beaks are not at the very end—a prolongation of the shell extends farther in front. The valves are thick, and the glossy brown epidermis wears a shaggy coat of hair, especially toward the ventral posterior area. The flesh is orange-coloured, the foot red. The mollusk harbours a little pea crab which is entirely free from spines. Found in muddy gravel, from low water to eighty fathoms depth. Or they hide in rock crevices, where they are washed by the tide at high water. In mud the mollusk stands vertical, its nose buried, its siphons up in the water. In the region of Vancouver this “great horse mussel” grows to be nine inches long and four inches wide. On northern coasts of England it may attain an equal length, though the average is about five inches. This is the size we commonly see it.

Habitat.—Cape Hatteras northward, California to Alaska, northern Europe.

The **Plaited Horse Mussel** (*M. plicatula*, Lam.) is narrowly and triangularly oblong, gibbous, spreading and compressed behind, plaited finely in radiating lines, especially strong over

the posterior area. The dark brown epidermis is tinged with yellow. Ligament long and strong. Lining silvery white. This is one of the most common mussels on the muddy tide flats of our east coast. It has the clinging habits of *Mytilus*. Length, 2 to 4 inches.

Habitat.—Nova Scotia to Georgia.

The **Tulip Modiola** (*M. tulipa*, Lam.) is oblong like a small *M. plicatula*, but striped with alternating rays of yellow and chestnut. It is the gayest of our native mussels, and is naturally a southern species. Length, 2 to 3 inches.

Habitat.—North Carolina to West Indies.

The **Straight Horse Mussel** (*M. recta*, Conr.) is long and narrow, with delicate, ventricose shell, shading from dark to lighter brown from the beaks outward, and becoming quite hairy toward the end. Length, 3 to 4 inches. Var. *flabella*, Gld., grows to greater size.

Habitat.—Vancouver to southern California.

Genus MODIOLARIA, Beck

Shell oblong, with hinge at one end, ribbed radiately, but with a plain central area separating the ribbed portions ; foot strap-shaped, very extensible. This mussel lives in rock crevices, in empty shells, or buried in the tests of simple ascidians. When moved to change its quarters it is active, and uses the tip of its foot as a prehensile organ, grasping stems of seaweed and other objects to help itself along. When a new place is selected, attachment is made by spinning a byssus.

The **Black Modiolaria** (*M. nigra*, Gray) changes its outer colour with age from purple or olive brown to black. Its outline is almost oval, the ribbed areas are crossed by concentric lines so as to form a fine network with knobs at the intersections. Length, 3 inches ; width, 2 inches.

Habitat.—Arctic seas to Cape Hatteras, Pacific coast, Europe.

THE ROCK-EATERS

Genus LITHODOMUS, Cuv.

Shell thin, cylindrical, inflated in front, wedge-shaped behind ; surface finely striated, often wrinkled and furrowed ;

The Mussels and Rock-eaters

dorsal line short; beaks minute, incurved; epidermis thick, dark ; lining pearly. When young, these mussels are suspended to rocks by the byssus. At maturity they bore into limestone rock and cannot turn around. The calcareous shell of *Spondylus* is often burrowed, especially of the ponderous species. The shell is often thickened by a limy deposit. The animal is luminous.

A small genus of forty species, well represented in the West Indies.

The **Rock-eater** (*L. lithophagus*, Linn.) is shaped like a pea pod, and has a smooth, chestnut exterior. It is found in coral rocks. Length, 2 to 3 inches.

Habitat.— Europe, West Indies, Florida Keys.

Genus LITHOPHAGUS, Muhlf.

The **Plumed Rock-eater** (*L. plumula*) Hanley, is very like the last. It burrows in rocks and old shells. Length, 1 to 2 inches.

The Mediterranean *L. dactylus* is highly esteemed as food.

Genus ADULA, H. & A. Ads.

The **Pea Pod Shell** (*A. falcata*, Gld.) is described by its name. The shell is thin and of the texture of rubber, white and pearly within, with a wrinkled brown epidermis. It is able to bore into very hard rock, forming a burrow to the sides of which it fastens itself by the byssus. Length, 2 to 3 inches.

Habitat.— California coast.

CHAPTER XXVIII: THE WING SHELLS, PEARL OYSTERS AND HAMMER OYSTERS

FAMILY AVICULIDÆ

SHELL oblique, valves unequal, right one smaller, always underneath; hinge line straight, much elongated; umbones eared, one ear wing-like; animal attached by byssus; foot small; mantle lobes fringed, free. Family mostly extinct; one thousand fossil species known, chiefly in Paleozoic strata. Of one hundred and twenty living species, not one is found in northern latitudes where fossils abound. Confined now to warm, temperate and tropical seas.

Genus AVICULA, Lam.

Shell oval, eared, posterior ear produced into a wing-like extension. Body small; byssus large. Many species secrete pearls. Twenty-five living and three hundred fossil species. The typical forms resemble in outline the profile of a bird in flight.

The **Saffron Wing Shell** (*A. crocea*, Lam.) has a long, slender wing-like extension of the hinge, almost twice the length of the oblique valves. The short anterior wing completes the bird figure, supplying the head and beak. This was Lamarck's type species. Who wonders that he called the genus *Avicula* — "little bird"? The trim outline of this elegant shell is that of a swallow, built for swift flight. Length, 4 to 5 inches.

Habitat.—Philippines.

A. heteroptera, Lam., has roundish, unequal valves, and long, tapering, dissimilar wings. Colour, bright chestnut, obscurely rayed. Length, 3 to 4 inches.

Habitat.—New Holland.

The **Great-winged Avicula** (*A. macroptera*, Lam.) combines unusual size with elegance of form. The straight, narrow wings extend like keen stillettos in opposite directions from the central hinge. The dusky valves are thin and marked with pale

radiating lines. Young shells are adorned with minute, fimbriated scales all over the surface. These disappear later. The pearly lining is beautifully iridescent. Length, 5 to 8 inches.

Habitat.— West Indies, Moluccas.

The **Atlantic Wing Shell** (*A. Atlantica*, Lam.) is reddish brown with numerous undulating wrinkles, separated into radiating series by white lines spreading from the umbones to the margins. The wrinkles are set with sharp spines, which are soon worn off with the fibrous epidermis. Wing, a straight, narrow blade. European forms, thin, pale, flat, long-winged and spiny, are a contrast to our thick, dark-coloured, smooth ones, with short wing and rounded, concave valves. Length, 3 to 4 inches.

Habitat.— Mediterranean, northward. North Carolina to Florida and West Indies.

The **Bearded Wing Shell** (*A. barbata*, Rve.) is orbicular in outline, with a straight hinge line, and no wing extension. This yellow shell bears series of concentric laminæ, which change near the margin into a series of regularly overlapping, spoon-shaped lobes, forming a heavy fringe. Diameter, 3 to 5 inches.

Habitat.— Panama.

The **Emerald Wing Shell** (*A. smaragdina*, Rve.) an elongated oval form, almost without a hint of a wing behind, is smooth and a rich dark green in colour. Yet it swings off very obliquely from the hinge, and is recognisable as an *Avicula* in spite of its unusual form.

The **Great Pearl Oyster** (*A. margaritifera*, Lam.) better known to the commercial world by its sub-generic surname, *Meleagrina*, is a wing shell with wings reduced to small angular projections near the hinge of the large, flat circular valves. The outside surface shows a coarse, laminated structure, of dull olive to smoke colour. Within, the thick pearly lining is a beautiful, iridescent expanse, interrupted by a central muscle scar.

When small, the valves are ribbed and wear a luxuriant growth of long, flat scales, twisted and curved like fronds of coral. These disappear as the shell grows larger and thicker. At maturity it is often ten to eighteen inches across and surprisingly heavy.

Pearl oysters live in tropical seas on clean, sandy bottoms fifteen to twenty fathoms down. The strong byssal cord thrown out through the hinge anchors the mollusk to coral masses or to

other shells, whence they never move until brought up by divers. These are the bivalves which for centuries have furnished the precious "oriental pearls," adding constantly to the treasure of kingdoms and individual collectors.

Mother-of-pearl, the thick lining of each valve, is the dependable product of pearl fisheries. It is secreted in annual layers by glands in the mantle. There is just enough animal substance in it to support the particles of lime carbonate. The iridescence is due to microscopic undulations of the various layers which compose it. These layers expose oblique edges to the surface, and the refraction of light produces the rainbow colours.

The best mother-of-pearl comes from healthy, full-grown shells ; the finest pearls from shells distorted by crowding and disease, and invaded by parasites and foreign particles. The first is a natural growth; the second abnormal. A lusty, well-fed mollusk, enjoying life, has a neighbour, warped, debilitated, suffering, with a grain of sand rolling around in its mantle folds. Coat after coat of nacre is added to this irritating foreign body to lessen its injury to the tender flesh. When the diver finds it, a magnificent pearl, it makes him rich. Only one shell in a thousand, we are told, contains a gem of any value. So the lines of Browning would do little, I fancy, to reconcile a discontented pearl-diver to his hard lot:

There are two moments in a diver's life:
One, when a beggar, he prepares to plunge ;
Then, when a prince, he rises with his pearl.

Throughout the seas of the equatorial regions are scattered pearl fisheries where thousands of people are engaged in diving for the pearl-bearing mollusks. Ceylon has ten, operated under government control. Nearest to us are the Panama and Lower California fisheries. Four to five thousand boats manned by divers work in the Persian Gulf each summer. The harvest of one year in this locality alone adds to the world's wealth in gems and mother-of pearl \$2,000,000. This is the average, according to official statistics. The shells are smaller, but of better-grade than those of Tahiti and of Panama. Australian fisheries produce small but very brilliant pearls. The Pacific Islands have many fisheries, noted the world over for their gems. The most famous pearls come from the Sulu Islands. Tahiti is the centre from which the products of the South Pacific fisheries are ex-

ported. Amsterdam, Hamburg, St. Petersburg, Paris and London are the great markets for these. Bagdad is the chief market for white seed pearls from the Red Sea and Persian Gulf. Bombay distributes round pearls of yellowish colour, for which Hindus have a preference.

White pearls are the most valuable, outranking yellow, green, pink and gray ones which are also held in high esteem, especially when two or more are perfectly matched. Globular pearls, free from flaws or discoloration, bring the highest prices. Pear-shaped ones rank next in value. Any form, so it be symmetrical and pleasing, is acceptable. Perfect pearls increase in price in geometrical ratio with increased weight and size. Pearls are not worked or polished, as most gems are. They are very soft, with a lustre nothing can improve.

No shells under five years old contain pearls of value. The growth of the sixth year doubles their value in mother-of-pearl. The seventh year again doubles it. The restriction of fishing protects these young mollusks, and prolongs the life of the industry which, when unrestricted, exhausts the beds. In many places diving suits are never used, and dredging is forbidden by law. A famous Chinese fishery is worked one season, then it is left undisturbed for ten or fifteen years.

The pearl fishery at Bahreim, on the Persian Gulf calls together for the spring season, March, April and May, thousands of persons. The divers bring their families, and build huts of palm and bamboo. Boats carrying fifteen to twenty men go daily to the banks which lie under ten to twelve fathoms of water.

The diver is naked, his body rubbed with oil. He stuffs his nose and ears with cotton. A clamp is often worn on the nose. He carries a knife to fight off sharks, and to loosen the oysters. A basket hangs on his neck. He has a bar with a large shot at each end under his feet. He is framed by three wooden pieces attached to the loaded bar. A rope lets this frame down and hauls it up in two minutes or less time. The diver has about seventy-five oysters. Fifty times a day he will take the trip.

The two great afflictions of divers are rheumatism and ulcers. The reward of this exhausting form of labour is a fluctuating, elusive thing. The uncertainty of it does not lessen its hold on the people who take it as a matter of course. The Ceylon fisheries give the diver one-fourth of his shells, divided when he



WING SHELLS, ROCK-DWELLERS AND A MUSSEL

- 1 Great-winged Avicula, *Avicula macroptera*.
- 2 Atlantic Wing Shell, *Avicula Atlantica*.
- 3 Peruvian Wing Shell, *Avicula Peruviana* with byssus.
- 4 Rock-eater, *Lithodomus lithophagus*, in its burrow.
- 5 Rough Rock-dweller, *Vulsella rugosa*, embedded in porous rock
- 6 Tulip Horse Mussel, *Modiola tulipa*.



OYSTERS OF TROPICAL SEAS

- 1 Pearl Oyster, *Avicula margaritifera*, which produces the Oriental pearls. The shell lining is the mother-of-pearl of commerce.
- 2 White Hammer Oyster, *Mallus albus*.
- 3 Common Hammer Oyster—*Mallus vulgaris*.

comes up. Another plan is to pile the shells until they open, when the soft parts are thoroughly scanned for free pearls, which are the most valuable, and the shells are cleaned for shipment as mother-of-pearl. At this time the diver gets his share.

In one of the best-managed fisheries in the South Sea Islands the divers work by contract that binds them for the season. They are paid by the ton for their shells, graded into three qualities. The pearls found belong to the divers, who sell them usually to the company. The best grounds are near the bases of large patches of coral, at ten to fifteen fathoms depth. Women and children make expert divers. All get excellent wages, which they squander upon tawdry finery at the company's store, and Saturday and Sunday are spent in carousing.

The *Albatross* on a recent cruise spent some time near this pearl fishery, and one of the party gives a vivid account of a visit to see the divers at work.

We took passage in one of the small cutters employed in the fishery, and on arriving at our destination made fast to a cutter anchored over a submerged growth of coral. Two other cutters were anchored close by. Three divers were on one boat and five on the other, one of whom was a woman. Each of the divers is provided with a water glass with which he scans the water before going down. The glass is sixteen inches square at the top, twelve inches at the bottom, and twelve inches deep. (A hollow cubical vessel.) It has a notch in the side in which to rest the neck. By its aid the bottom can be seen to a depth of twenty fathoms, and shells located. By locating clumps of shells before going down, much labour is saved. Instead of the diver exhausting his energy in diving at random and searching for shells after reaching bottom, he goes directly to the spot where the shells lie. At other times, in shallow water, he goes down to explore the bottom. In this way clusters of shells are located before any are taken.

Before descending, the divers sit around on deck for some little time, inflating their lungs to the fullest capacity, exhaling the air through the mouth, making a low, whistling sound. No clothing is worn except a breech cloth. On the shoulders is carried a bag net in which to put the shells. It is made of coconut fibre and is about twenty inches deep and twelve inches across; size of mesh, $2\frac{1}{4}$ inches. It offers little resistance and will carry all the shells a man can bring to the surface. In the left hand is carried a pearl shell, which serves the same purpose as a knife. With it obstacles are removed from the bottom and shells are loosened from their bed. The right hand is protected by a white cotton mitten.

When ready to descend, the diver slips over the side of the boat, holding to the rail with one hand and holding the water glass in the other. Locating some particular point at the bottom, he lets go of the rail, drops the glass, takes a deep breath and sinks out of sight, feet foremost. Descending about ten feet, he quickly turns head downward, and swims to the bottom. When hardly a third of the distance has been reached, he has the appearance of being on the bottom, so transparent is the water. On reaching it he places himself in a horizontal position, seemingly hauling himself along from one point to another.

One man consented to give an exhibition dive in deep water. The cutter was dropped off a short distance from the shoal, and a sounding made in seventeen fathoms (102 feet) of water. We watched through water glasses the diver's movements from the time of sinking below the surface until rising to the top again, two minutes and forty seconds.

Reaching his destination, he began picking over pieces of coral, brushing aside broken shell and other debris in the same manner as if he were working in a garden. He investigated the bottom for some sixty or seventy feet from the initial point of landing. When ready to ascend he stood erect, and came up as if being pulled with considerable force, shooting out of the water half-way to the waist. He seemed to suffer no unusual discomfort, and in a short time was ready to go down again. There is a record dive of twenty-three fathoms.

THE PERNAS

Genus *PERNA*, Brug.

Shell nearly equivalve, squarish, flattened, right valve with byssal sinus; hinge broad, crossed by a series of ligamental grooves; umbones small, often terminal and hooked. A small genus with variable forms in tropical seas, chiefly eastern.

The **Saddle Perna** (*P. ephippium*, Linn.) is well named from its general outline. The coppery-red surface is covered with wavy laminations that seem to have fused and become obsolete. The anterior end has a deep concavity. The umbones form a hook. Diameter, 4 to 5 inches.

Habitat.—Honduras.

The **Purse Perna** (*P. marsupium*, Lam.) has much the same form as the pearl oyster. It is a small species from the Philippines.

The **Pod Perna** (*P. legumen*, Rve.) is a small quadrangular white shell, three times as long as it is wide.

The **Carpenters' Square** (*P. isognomum*, Rve.) is a well known representative of this genus. The elongation of the body of the shell seems to shorten the wing, and vice versa. The angle formed is close to ninety degrees. Colour, dark purple. Length, 6 to 10 inches.

Habitat.—Philippines.

The **Bat Perna** (*P. vespertilio*, Rve.) strikingly imitates the shape of a bat's wing. It is yellowish white, tinged with purple. Length, 6 to 8 inches.,

Habitat.—Bay of Manila.

THE HAMMER OYSTERS

Genus **MALLEUS**, Lam.

Shell nearly equivalve, elongated, irregular; dorsal margin prolonged almost at right angles with the valves. A small genus distributed in Chinese and Australian seas.

The **Common Hammer Oyster** (*M. vulgaris*, Linn.) is the type, and Lamarck could not but call the genus *Malleus*, for there was the handle and head of this familiar tool closely imitated by the valves and elongated wings of the new and unknown mollusk. The coarse, thick valves are drab or black and undulated. They frequently slant obliquely from the hinge line, and curve decidedly. In early life the shell is like those of *Avicula* and the byssal cord passes out through a deep sinus in the right valve. Later the extension of the valve in three directions gives it the characteristic form, and the byssal sinus is midway between the two valves, causing an indentation of each. The lining shows that the body lies in a roundish space near the hinge, attached by a large muscle scar. Length, 6 to 8 inches. Width, 8 to 10 inches.

Habitat.—China Seas.

The **White Hammer Oyster** (*M. albus*, Rve.) differs from the preceding species by being colourless, and of finer and more horny texture, and less rude pattern throughout. Length and width, 6 to 10 inches.

Habitat.—Philippines.

The Wing Shells, Pearl Oysters and Hammer Oysters

By a strange chance, the species discovered since the genus was first built up on the characters of *M. vulgaris*, have, with the exception of *M. albus*, lacked the peculiar double-winged prolongation at the hinge. The others are headless hammers, with valves of considerable irregularity of form. However, the name stands, describing the largest and most important members.

CHAPTER XXIX: THE PEN SHELLS. SEA WINGS. FIN SHELLS

FAMILY PINNIDÆ

Genus PINNA, Linn.

SHELL equivalve, wedge-shaped, oblique, thin, fragile, and generally scaled; hinge lateral, toothless; umbones terminal anterior; ligament in long groove; mantle double-fringed; foot long, spinning strong cord. Osphradium developed into a finger-like process that can be extended beyond the shell margin. Large genus in warm seas of Old and New World.

The **Rude Pen Shell** (*P. rudis*, Linn.) is irregular in growth, blistered, whitewashed on the orange-red surface. Semi-tubular scales, large and few, adorn the indistinct radiating ridges toward the margin. Length, 8 to 10 inches.

Habitat.— West Indies.

The **Noble Pen Shell** (*P. nobilis*, Linn.) shows a startling crowded array of erect, recurving prickly scales pointing in various directions, on the outer portion of its triangular shell. The tapering stem is scantily set with scales. The ground colour is olivaceous at the umbo becoming rosy as it spreads outward. The scales are yellowish. Length, 6 to 7 inches.

Habitat.— Mediterranean.

The **Half-naked Pen Shell** (*P. seminuda*, Lam.) is covered with erect, delicate scales, that follow the lines of growth. On the outer posterior area they are largest and are set on radiating lines. Forward and approaching the umbones the scales become gradually so minute and worn down that the apical half is bare. This shell is thin, of smoky, transparent, horny texture lined with pearl. The lips meet in a straight line. Length, 6 to 10 inches.

Habitat.— North Carolina southward.

The **Prickly Pen Shell** (*P. muricata*, Linn.) is triangular, with straight lips and incurving side lines. The obscure ribs are

set with erect, open, triangular scales. The horny shell substance is white and semi-transparent. Length, 6 to 8 inches.

Habitat.— North Carolina to West Indies.

The **Black Pen Shell** (*P. nigra*, Chemn.) spreads widely from a narrow beak, and is constantly black. It rounds at the lips. One specimen may be small and show a formidable array of semi-tubular scales erect on the radiating ridges. Others, remarkable for size, are smooth. Length, 6 to 15 inches.

Habitat.— South Seas and Philipines.

The **Philippine Pen Shell** (*P. Philippinensis*, Henley) is a greatly elongated, narrow, straight-lipped Pinna with smooth, pearly surface. Its colourless ground shows narrow smoky streaks. Length, 8 to 12 inches.

The **Rough Pinna** (*P. rugosa*, Sby.) is a strongly ribbed and extravagantly tubercled species. The outline widens abruptly from the narrow, stem-like umbonal region to the front, which bears semi-tubular, leaf-like scales that twist very irregularly. Colour, dark smoky. Length, 10 to 18 inches.

Habitat.— In sand banks, Panama Bay.

The **Moor Pinna** (*P. Maura*, Sby.), dark brown to black, its posterior half covered with regular lines of similarly curving tubular scales, is another handsome Panama species. Length, 6 to 8 inches.

Oldroyd's Pen Shell (*P. [Atrina] Oldroydii*, Dall), a solitary specimen, was taken up alive from a depth of twenty-five fathoms by fishermen in San Pedro Bay. They brought it to Mr. and Mrs. Oldroyd, of Long Beach, Cal., who recognised it as the first member of its genus reported from this part of the world. The remarkable "find" was nine inches long, and nearly black, the lining gray with some iridescence. Dr. Dall published the description of it in 1901.

CLOTH OF GOLD

The anchor by which pen shells are held fast to rocks on the sea bottom deserves special mention. More familiar to us is the byssus of black threads by which mussels hang in clusters to to bridge and wharf timbers below the water line. Pen shells exude a gummy secretion through a sieve of much finer holes. When exposed to the air this rope is found to be composed of

golden threads of silky texture and extreme fineness. Long ago it was spun and woven into cloth by the people of Mediterranean countries, where *Pinna nobilis* is abundant. Robes of marine silk were much desired articles of commerce, under the name "tarentine." A pair of gloves could be folded away in a walnut shell, and a scarf of considerable size in a snuff-box, so fine and supple were the delicate threads.

Fishermen, especially off the Sicilian coast, rake these mollusks off the rocks in considerable quantities. The byssus is torn off and sold to country women who wash it with soap and card it. In this crude process, much is lost. The threads are spun and woven into fabrics so soft as to rival the finest silks.

Nowadays this cloth is manufactured in Palermo and Lucca, but chiefly for its rarity. Shawls, scarfs, gloves and stockings, may be seen in great exhibitions as high examples of textile art.

The web is of a beautiful yellow brown, resembling the burnished gold hue which adorns the backs of some splendid beetles.—*Simmonds*.

CHAPTER XXX: THE THORNY OYSTERS

FAMILY SPONDYLIDÆ

Genus SPONDYLUS, Linn.

SHELL irregular, attached by right valve, rarely free; valves radiately ribbed, set with spiny or leaf-like scales; hinge of two curved, interlocking teeth in each valve; mantle open; gills separate; foot small, cylindrical. Inhabits warm seas. Living species seventy; fossil eighty.

The thorny oysters were known by name, admired and eaten by the early Greeks long before most shell families had been discovered. The warm Mediterranean shores harboured the royal-hued Ass's Foot Spondylus, *S. gædaropus*, Linn., and others. The Swedish systematist retained the name given it by Aristotle, who saw under the sharp prickles and curving flat spines two valves shaped like a compact little hoof. The purple of the upper valve contrasts oddly with the orange that is mingled with white on the under valve. The combination is peculiarly rich and attractive.

Collectors have always desired to have these showy bivalve shells. They are all striking in ornamentation and colouring. Even the distortion of form that results from their crowding as they grow, attached firmly to rocky formations or to other shells, adds interest, for it tells something of the life they live.

We shall not find any species nearer than the Bermudas and West Indies, Mexico and the Gulf of California. The adjectives before their names will indicate the striking character of some of the species: dyed, variegated, painted, strawberry, orange, yellow, crimson-dyed, amber, dusky, violet, white-spined, many-spined, bearded, cat's tongue, leafy, hedge-hog, porcupine, branched, fingered, crumpled. Some aristocrats are called royal, princely and imperial.

The **Variable Thorny Oyster** (*S. varians*, Sby.) is great in size and thickness, weighing several pounds. Its oval valves,

sometimes two or three inches thick, have their dense cover of flat spines entirely overlaid with a chalky lime deposit. Only a remnant of colour, orange or purple, remains tinging the fluted lips inside, and the beak. Wide ruffles extend out from the sides of some specimens. The white lining is china-like, with deep muscle scars.

The peculiarity of the attached valve is that it contains water chambers, flat, extensive, between the layers of the growing shell. The border of the mantle deposits material faster than the hinge area. In early stages the upper valve is bright rose colour, with three narrow dark ridges. Subsequent growth is colourless. Length, 5 to 6 inches.

Habitat.— Pacific Islands.

The **Lime-Carrier** (*S. calcifer*, Cpr.), with ruby lips, has its orange-coloured spiny face quite buried under burdensome deposits of lime. This species seems much like its predecessor, but is more compactly built. Diameter, 5 to 8 inches.

Habitat.— Panama to California.

The **American Thorny Oyster** (*S. Americanus*, Lam.) varies in its shape and the character of its spines. The scallop-like, eared valves are whitish or brightly painted with yellow, and shades of red. The valves are ribbed, the area sub-divided by six extra ribs of greater size. The spines vary from needles, long and short, to broad, laminate frills, irregularly formed and distributed on a given specimen. The texture throughout these forms is china-like. Length, 3 to 6 inches.

Habitat.— Bermuda, West Indies.

The **Imperial Thorny Oyster** (*S. imperialis*, Chemn.), one of the most beautiful of its tribe, is fortunately abundant, and quite common in collections. Its valves are similar, round and eared like a scallop shell. Six main ridges separate the low ribs into groups of threes. Sharp spines, a single row on each ridge, cover the surface. The short ones on the secondary ridges are re-curved and each has a basal pair of minute points. The long primary spines overlap each other. This species never attaches itself, but remains free through life. The rosy flesh tint of these elegant shells deepens between the ridges. Diameter, 2 to 3 inches.

Habitat.— China.

The **Royal Thorny Oyster** (*S. regius*, Linn.) larger, more

The Thorny Oysters

ventricose, the upper beak quite overhanging its mate, is rather more elaborate in ornamentation than the previous one, though made on the same plan. The primary spines are longer, and flung out at various angles. More and finer ridges separate the six principal ones. The colour is rose purple. This species has the longest spines of all. Diameter, 3 inches.

Habitat.—Pacific Islands.

The **Painted Spondylus** (*S. pictorum*, Chemn.) has its six main ribs very regularly set with tongue-shaped spines. Intervening ridges have similar spines or sharp pointed prickles. Some are coloured with shades of rose. More commonly they are rose and orange, or a rich salmon yellow. Some that begin life with a coloured shell abandon the scheme and produce a white border. No species is more variable in colouring than this. It is fastened to coral rocks at a depth of fifteen to eighteen fathoms. Length, 3 to 5 inches. Lower California, Mexico, Colombia.

THE PLAITED SHELLS

Genus **PLICATULA**, Lam.

Shell irregular, oblique, attached by umbo of right valve; valves usually plaited. Few living species.

The **Plaited Shell** (*P. ramosa*, Lam.) is a little flattened clumsy bivalve, with rusty hair lines on the plaited surface. The hinge locks by two teeth on the left (upper) valve which are inserted between the two set wide apart on the right. These sedentary mollusks appear to accumulate limy deposits on the shells as age advances, and serpulæ and barnacles become attached. West Indian specimens are largest. Length, 1 inch.

Habitat.—North Carolina southward.

P. Mantelli, Lea., found on our Gulf coast as fragile flat valves, indistinctly eared at the hinge, faintly ridged and delicately marked with brown, are a trifle smaller than *P. ramosa*.

THE FOOT SHELL

Genus **PEDUM**, Brug.

Shell wedge-shaped, thin, nearly smooth, flattened, slightly curved; right valve convex and deeply notched for passage of the byssus. A single species is known.

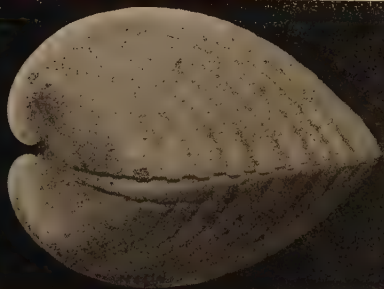


PEN SHELLS

- 1 Spiny Pen Shell, *Pinna muricata*.
- 2 Swollen Pen Shell, *Pinna saccula*.
- 3 Californian Perna, *Perna californica*.
- 4 Noble Pen Shell, *Pinna nobilis*, with skin of its golden-threaded byssus.



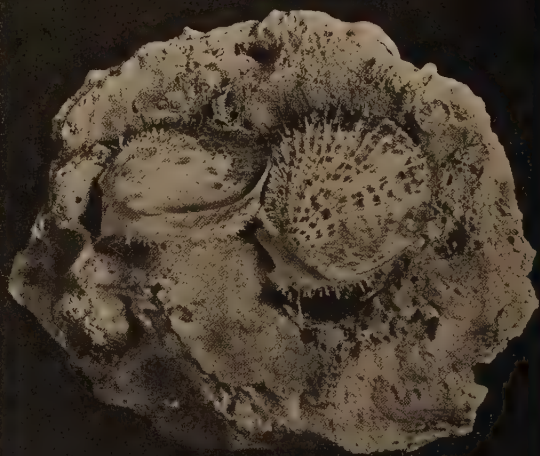
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THORNY OYSTERS AND OTHERS

1 Royal Thorny Oyster, *Spondylus regius*.
2 Twisted Ark Shell, *Arca tortuosa*.

3 *Hemicardium* sp.

4 Imperial Thorny Oyster, *Spondylus imperialis*.
5 Nicobar Thorny Oyster, *Spondylus Nicobaricus*.

The **Thorny-oyster Foot Shell** (*P. Spondyloideum*, Gmel.) has an outline somewhat suggesting the human foot. The animal between these flat valves must be very thin. It was first described as an oyster, and it long enjoyed a reputation for rarity. It is found most abundantly in the Red Sea where it is partially buried in coral reefs. Colour, brownish red in indistinct concentric bands on a paler ground. Length, 3 inches.

CHAPTER XXXI: THE FILE SHELLS

FAMILY LIMIDÆ

Genus LIMA, Brug.

SHELL obliquely oval, eared, white, gaping at the sides; hinge toothless, with triangular ligament pit; umbones well apart; surface sculptured with radiating ridges bearing numerous imbricated, spiny points; mantle inflated, bag-like, open, fringed at border, set with eyes; foot finger-like; gills 4, equal on each side, distinct. A large family, mostly extinct.

The roughened surfaces of all these white shells suggest that they might serve as rasping tools. The scoop shape is constant. The depth of the shells is variable. Chiefly inhabitants of the Red Sea and Mediterranean, yet a few species are scattered in the East and West Indies, Australia and Northern Europe.

In more ways than a few the file-shells resemble the scallops. But they outdo them at many points. A school of youngsters with shells like carved ivory, flit through the water, zigzagging with all the suddenness and swiftness of the scallops, but they go hinge foremost, and trail after them a graceful and copious sheaf of long mantle tentacles. They often throw these about each other, and thus adhering, swim by twos and threes. Drawn in, these fringes are rigid horns guarding the gaping valves. Dr. Jeffreys had a Lima in his aquarium which clasped his finger with its tentacles. He drew it about for awhile, then attempted to shake it off, but failed. He had to tear several filaments from the mantle; and even then, they continued to writhe and cling as if alive and determined to hold on. They were removed with considerable difficulty.

When free life palls, the Lima can attach itself by a byssus. This is detachable at will. Many prefer to remain stationary, so they build about their shells a web of byssal threads, plastered with slime in which fragments of shells, seaweeds, coral, and

pebbles have place. Strangely enough, two or three young ones may be found in one nest, but adults are alone, in such close quarters that they cannot turn around without the greatest effort. But they are able to move up and down, as the nest is funnel-shaped. They retire when prowling crabs and hungry fish approach.

The **Oriental File Shell** (*L. orientalis*, Ads. and Rve.) is found with its interesting nest attached to stones well off our west coast. Mrs. Oldroyd described one she took from the dredge at San Pedro, and put into a jar of sea water. It came out of the nest and swam gracefully about, occasionally putting the foot out as if to help it along. The white shell, obliquely oval, and set with rows of fine, file teeth, had rose pink mantle fringes, short but numerous, which merged into white for one-third of the border. This species is *L. debiscens*, Conr. Length, 1 to 3 inches.

Habitat.—Monterey southward, California.

The **Gaping File Shell** (*L. bians*, Gmel.) has strong, rough ribs, and in all particulars seems able to take care of itself. The body is red, and the mantle orange, trailing a thousand long filaments, that curl and twist constantly, like the tentacles of a sea anemone. In the nest of this species the little porcelain crab lives, with full consent of the owner. It probably acts as scavenger, keeping the house clean in exchange for its lodging. Length, 2 inches.

Habitat.—British Isles.

The **Fragile File Shell** (*L. Loscombii*, Sby.) small, finely ribbed, and delicate, with bright orange body and tentacles, lives on muddy bottoms from shallow water to one hundred fathoms depth. Cod and other fish are very fond of this little bivalve. To escape the enemy it bores holes in clay bottom to hide in. Nests cunningly covered with bits of shells and other debris are built where the bottom is too hard to burrow into. Length, 1 inch.

Habitat.—British Isles.

The **Excavated File Shell** (*L. excavata*, Chemn.) is the largest species now living. Its oval valves are thin and shallow, the surface faintly cross-striated. The posterior ears are well developed; the anterior ones are drawn in, forming part of an excavated area that is sharply angled on the thickened margin

The File Shells

of the left valve. Through the opening made by this marginal angle, the byssus passes out. Length, 4 to 5 inches.

Habitat.—Norway.

The **Rough File Shell** (*L. scabra*, Dillw.) has its ridged surface set with small pointed scales, and covered with a yellowish epidermis. The shell is comparatively thick and ovate, with the large, anterior ears reflected. Length, 2 to 4 inches.

Habitat.—Southern Florida, West Indies.

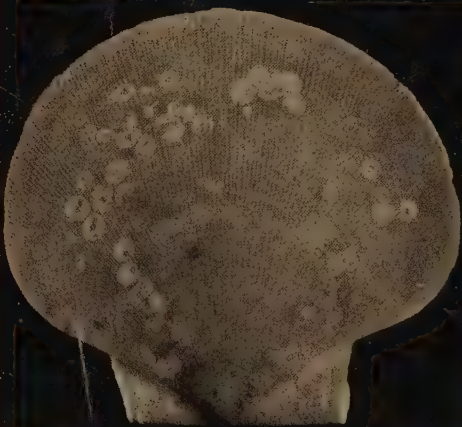
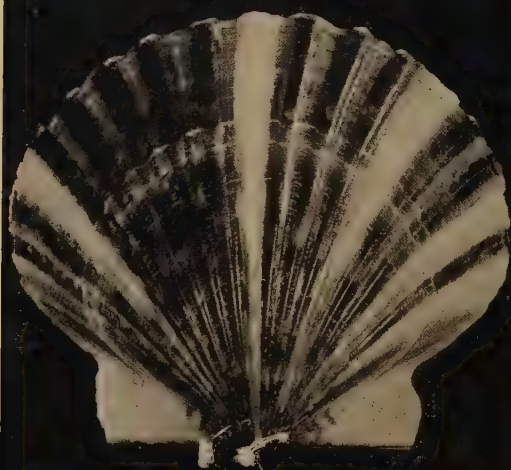
The **Friiled File Shell** (*L. squamosa*, Lam.) has its rounded ridges decorated with erect, flat, scaly plates. The general outline of each valve is obliquely ovate. The ears are small and depressed, the hinge oblique. Length, 1 to 3 inches.

Habitat.—Red Sea, Mediterranean, West Indies, Philippines.



MARINE BIVALVE SHELLS

- 1 The Half-bare Pen Shell, *Pinna semi-nuda*.
- 2 The American Thorny Oyster, *Spondylus Americanus*.
- 3 The Scaly File Shell, *Lima squamosa*.



SCALLOPS AND A FILE SHELL

- 1 Rayed Scallop, *Pecten irradians*.
- 2 Northern Scallop, *Pecten Islandicus*.
- 3 Great Scallop, *Pecten maximus*.
- 4 Rough File Shell, *Lima scabra*.
- 5 Magellan Scallop, *Pecten Magellanicus*.

CHAPTER XXXII: THE SCALLOPS. COMB SHELLS

FAMILY PECTINIDÆ

SHELL bivalve: free or attached, orbicular, ribbed, unequal, with ear-like extensions of the hinge line; internal ligament in pit under beak; foot small, finger-like, with large byssal gland; mantle open, with double border of fringed tentacles, and row of conspicuous eyes; siphons none.

Genus PECTEN, O. F. Müll.

Characters of the family. Distribution world-wide. Two hundred species. Multitudes assembling on a restricted area, form "scallop banks" from which are dredged several species used as food. The adductor muscle is eaten. Found in shallow water to two hundred fathoms depth.

The scallop's shell is admirably adapted to protect without overburdening its occupant. The valves are arched and plaited to give the greatest strength with the minimum of weight. The wide hinge is the fulcrum upon which the central adductor muscle acts to shut the two valves at will, and the resilient ligament opens them.

The shell rests upon the right valve, which is arched and smooth and pale compared with its mate. The anterior ear is the more prominent one. There is a close interlocking of the margins when the muscle contracts, except for a misfit of the large ear. A notch permits the passage of the byssus, the cord by which the mollusk attaches itself. A glutinous secretion of the byssal gland is extruded from pores, and these threads are manipulated by the finger-like foot to form a rope before they become toughened by their contact with sea water.

Young scallops are all able to spin this byssus at will. They tether themselves by it to objects on the sea bottom, and cast

The Scallops. Comb Shells

off their anchor rope when they wish to be free again. Adults, with a few exceptions, abandon the byssus habit. The common Mediterranean *P. varius* retains it through life.

To see hundreds of scallops the size of a silver dime flitting through the shallows on a bright summer day will certainly convince you that even mollusks can express the joy of living as plainly as a flock of blackbirds or a troop of boys bound for "the old swimmin' hole." Not every beach furnishes this spectacle, nor every day. The abundance of scallop shells on the sand determines the location of the banks. At low tide the youngsters are to be looked for in tide pools and in the shallows near shore. They snap their shell lips together with a succession of clicking sounds ; at each contraction of the great muscle a jet of water is thrown out under the ear, darting the body forward, sometimes a yard or more, always in a straight line. Changes of direction are made with great dexterity at the end of a stroke, a zigzag course enabling the mollusk to escape capture.

No creature that lives in the vasty deep can be prettier than these daintily sculptured, gaily painted shells, full of life and grace of motion, sometimes trailing behind them plumes of seaweed. Look where the opening lips show the fringed mantle margins. They are as brilliantly coloured as the shell. A row of bright eyes heads the fringe. Each eye is an iridescent green spot, encircled by a rim of turquoise blue. Some authorities doubt that these eye spots are more than phosphorescent, illuminating organs. Yet they have the cornea, lens, choroid coat and optic nerve. Dr. Cooke calls them *bona fide* eyes, approximating more closely to vertebrate eyes than any other found among bivalve mollusks.

The scallop does not crawl nor burrow. The foot is dwarfed till it passes easily in and out of the byssal notch. The locomotor function belongs to the single adductor muscle. This is the part we eat. It is strange that the inactive oyster has so tough a muscle that we discard it, counting the remainder a delicious morsel. The scallop's hard-worked muscle is a white and tender bite that tastes like lobster meat. We eat it joyously, casting away the soft parts with the shells. The scallop is in season the year round. It is prepared in a multitude of ways. Fried like oysters it is delicious. Stroll down some Saturday night on one of the avenues in New York where the push cart market is in

full swing, and all the races of the earth are represented in the throng. They stand in line before a strenuous little German who skims scallops out of a pot of boiling fat, set over a coal fire in the throat of an open chimney. His flustered helpmeet hands him fresh scallops, rolled in cracker dust, with a dash of salt and pepper. He cannot keep ahead of his waiting line of customers.

The "quin" and the great scallop are the edible species of Europe. Ours is the widely distributed *P. irradians*. The shells of all large species are used to "scallop" oysters in. They have always served as drinking cups; the flat valves as plates. Fancy articles made of these shells load the shelves of curio stores. It is a pity that such pretty shells should be tied and glued together to make silly and impractical purses, pin cushions and "jewel caskets." The souvenir hunter's appetite is incited and appeased by these meaningless and inartistic things, cheap in everything but price. Dead shells are put down as "clutch" in new oyster beds.

Scallops are very desirable tenants of the aquarium. It is astonishing how few persons familiar with the sea know of the antics of these youngsters. Show your "dancing scallops" to them. Call attention to the byssus that anchors those on the bottom. Show the brilliant eyes and the wonderful tactile organs that fringe the mantle by putting a specimen into a tumbler of water. There is plenty of food for these mollusks in fresh sea water in a balanced aquarium.

One way to catch full-grown scallops for the same purpose is to troll with a fish line without hook or bait over ground they are supposed to inhabit. The first scallop whose tentacles are tickled by your line snaps his valves tight on it, and you pull him up. Take care that in handling him you do not get a severe pinch.

The Pilgrim Scallop (*P. Jacobæus*, Linn.) wears a halo of romantic and historic interest. No other mollusk enjoys such distinction. Its renown had a very commonplace beginning. Scallops are abundant on the coast of Palestine. A member of the First Crusade starting home picked up a pretty shell and stuck it in his hat, or pinned it to his cloak. He set the fashion. Whoever wore the badge was recognized throughout Christendom as a Crusader; he had been to the Holy Land. Orders of

knighthood growing out of the Holy Wars incorporated the "St. James scallop" in their ensigns. Proud old families commemorated by the same symbol in their armorial bearings the deeds done by their ancestors against the Saracen hosts. Until the Age of Chivalry is forgotten the scallop will be remembered as its emblem.

Its graceful lines have always appealed strongly to the artistic sense of various peoples. It has an envied place with the acanthus leaf and certain other natural objects in the development of historic ornament.

The upper valve of *P. Jacobæus* is flattened and strongly fluted, with a saucer-like excavation near the beak. The right valve is deeply convex, with squarish, radiating ribs, each bearing four incised ridges. Across the ridges run close, elevated striations, roughening the entire surface. The ears are prominent and nearly equal. The flat valve is dark red, variously mottled; the dipper is almost colourless. Diameter, 3 to 5 inches.

Habitat.—Mediterranean.

The **Great Scallop** (*P. maximus*, Linn.) sometimes called "the great clam," strongly resembles the pilgrim scallop in form and sculpture. Often the upper valve sinks into the lower, as if a size or two too small. It is dark red, brownish in the grooves, fading toward the beak. The under valve is pink. The mantle is fawn-coloured; the body bright orange. This edible species is brought from banks off the Irish coast to the London market. The shells are sold for "scalloping" oysters. Diameter, 4 to 5 inches.

Habitat.—Northern coasts of Europe.

The **Quin or Queen Scallop** (*P. opercularis*, Linn.) is a thin-shelled species, with rounded ridges equal to the grooves between them. The colours range from brown to yellow, and through all shades of purple and rose, sometimes plain, oftener mottled and variegated.

This is the little scallop of the English markets, taken from dense banks, which shift, owing to the persistence of the "flying" habit. Quantities are taken up by oyster dredges, and sold at a few pence per hundred. Diameter, 2 to 3 inches.

Habitat.—European coasts.

The **Hunchback Scallop** (*P. pusio*, Linn.) is the ill-fated member of the family. It is a pretty, symmetrical infant, but

soon attaches itself for life, just as an oyster does. Inevitably it chooses cramped quarters, the interior of a shell, or a narrow cranny in a mass of coralline rock, where it becomes dwarfed and distorted. The spiny scales may express its irritability of temper. Diameter, 2 to 4 inches.

Habitat.— Rocky coasts of Europe.

The **Noble Pecten** (*P. nobilis*, Rve.) has a massive, strongly ribbed shell, with equal, polished valves, almost circular in outline, and prominent, unequal ears. The flesh-tinted ground colour is radiately banded or clouded with rose purple or saffron. Diameter, 6 inches.

Habitat.— Japan.

The **Knobbed Scallop** (*P. nodosus*, Linn.) has blunt nodules along the nine strong ribs; those near the ventral margin are squamose folds — apparently knobs in an unfinished state. The two valves are alike, flattened, and a uniform rich, dark orange or red. The large ears are unequal. Diameter, 3 to 4 inches.

Habitat.— West Indies, Mexico.

The **Northern Scallop** (*P. Islandicus*, Müll.) is a lover of deep water along the coasts of the North Atlantic. It took its name from Iceland, where it was first discovered. Its handsome, circular valves are scored with a multitude of fine, scaly, ribs which persist on the inside of the shell. The left valve arches over the right, and is banded with circles, alternately dark and light. Purple, red, orange, salmon and bright pink specimens are before me. The most beautiful one is white with concentric bands of pink. The anterior ear is much the larger.

This species is rare in collections, even on its native coasts. Storms that drive inshore with unusual force may throw a few on the beach. Diameter, 3 inches.

Habitat.— Europe, New England.

The **Magellan Scallop** (*P. Magellanicus*, Gmel.) is the largest American species. Though found only in northern waters it has been confused with a Patagonian species, and the name clings. The valves are circular and dissimilar, gaping in front of the large, almost equal ears. The surface of the valves bears a great number of uniform radiating ridges, crossed and roughened by fine, upturned scales. The left valve is rose-coloured, deepening

toward the beak. The flat right valve is almost white. A deep water species. Diameter, 5 to 6 inches.

Habitat.—Newfoundland to New Jersey.

The **Beaming Scallop** (*P. irradians*, Lam.) is the most common species on the Atlantic coast, the edible scallop usually sold in our seaboard cities. Tons are dredged from the Jersey banks annually, and the demand is increasing. The shells sell also for "scalloping" shell fish, and for making fancy articles.

The outline of the valves is almost circular, with prominent, almost equal ears. The surface bears about twenty high, rounded ribs, separated by rounded grooves. The exterior is brown, with concentric pale zones and radiating bars of red, purple or orange. A medley of rich colours is not uncommon. The lining is white and polished. A shallow water species. Diameter, 2 to 3 inches.

Habitat.—New England to Cape Hatteras.

P. dislocatus, Say, replaces the preceding species below the Cape. Both its valves are convex, and set with close, rounded ribs. The ears are almost equal. The white ground is variously decorated with red or yellow in zigzag cross lines or in mottled designs. It occurs in a great variety of colors and patterns on the coast of Florida. In the shallow pools the young disport themselves, swimming about in gamesome mood. If frightened, they stir up the muddy bottom, and flee under the cloud that furnishes ample protection. Diameter, 1 to 2 inches.

Habitat.—North Carolina southward.

The **Blunt-knobbed Scallop** (*P. subnodosus*, Sby.) is the most ponderous living species, named for the obscure raised nodules on the strong ribs. The surface is sharply striated and dark purplish brown, cross-waved with white. Old specimens attain surprising thickness and weight. They are as large as *P. maximus*.

Habitat.—West coast of tropical America.

The **Weather Vane Scallop** (*P. caurinus*, Gld.) has flat, thin, very broad valves, with small ears, and about twenty low ribs. A very fragile, dark brown shell. Diameter, 5 to 6 inches.

Habitat.—Northwest coast.

The **Pink Pecten** (*P. hericeus*, Gld.) is white, rayed with pink; the cardinal ridges are toothed, and separated by wide channels. The ears are unequal. Diameter, 2 inches.

Habitat.—Washington to California.

The **Speckled Scallop** (*P. æquisulcatus*, Cpr.) has the symmetry of form, the even fluting and the various colouring and markings of the scallops of our warmer Atlantic coasts. Its scheme of colours leans toward shades of brown. Diameter, 2 to 3 inches.

Habitat.—Southern California.

P. Diegoensis, Dall, has a dark red, flattened upper valve, with twenty distinct ribs. The lower valve is yellow. Diameter, 3 to 5 inches.

Habitat.—San Diego, Cal., northward.

This large scallop has a companion in the Californian cap shell (*Capulus Californicus*, Dall) which clings to the under valve, at the left of the hinge, close to the byssal notch. White within, dingy brown and shaggy without, it may well be mistaken for a wad of dead seaweed clinging to the larger shell. It is about an inch and a half long.

P. distorsum, Da C., attaches itself inside the shell of another species. The under valve of the parasite becomes imbedded in the lining of its host's shell. We can imagine this arrangement involves much discomfort for both partners, as growth proceeds.

The **Spear Scallop** (*P. hastatus*, Sby.) is ovate, with comb-like rows of spines on each of the ten most prominent ribs. These are worn off of the right valve. The colours are vivid; red, purple and yellow in different shades are seen. Free-swimming forms, alike on both valves, and spineless, are local forms. The young are spineless.

The animal alive in an aquarium shows not only the beauty of its rosy shell set with rows of spears. The body is a rich orange colour, set on the mantle margin with black eyes. The flesh is so transparent that the action of the heart and other organs can be seen by removing one valve. Young specimens can attach themselves at will to the stems of seaweed. Thus they rest when tired of swimming.

This deep sea species seems to correspond in its characters to *P. Islandicus*. Diameter, 1 to 2 inches.

Habitat.—California.

The **Broad-eared Scallop** (*P. lati-auratus*, Conr.) has unequal ears almost as broad as the fragile, oblique, fluted shell. The brown or orange surface is crossed by zigzag streaks of white. Diameter, 1 inch. Southern California.

The **Japanese Scallop** (*P. Japonicus*, Lam.) exhibits the peculiarity of a smooth, polished exterior, and a series of strong radiating ribs inside. There are fine concentric lines of dark red spaced with hair lines of white on the flat left valve which is uppermost. The two gape below the small, dark ears. The interior is white, with a soft lustre, and a rim of bright yellow. Diameter, 4 to 5 inches. Japan.

The **Many-coloured Scallop** (*P. varius*, Linn.) ought to be mentioned for it is seen in many American cabinets and always attracts attention. The arching valves are scored into twenty to thirty sharp ridges, uniform and armed with prickly scales, that sometimes broaden into horny plates. Colours and markings are indeed various, as the name implies. Reds of many shades, clear yellows, rich orange and browns, and dull grays are seen, each shell one-coloured, and obscurely mottled with white. In a few specimens two or more colours are combined, but usually not. Almost black specimens occur. The ears are very unequal, the byssal notch large. This scallop retains through life the habit of attaching itself at will. Its favourite station is a branch of the seaweed *Laminaria*. Diameter, 1 to 2 inches.

Habitat.—Mediterranean Sea to British Isles and Norway.

The **Purple-hinged Scallop** (*P. giganteus*, Gray) begins life as a free, symmetrical and very pretty little scallop, changes its mind later, settles down, like the hunchback, to a hard life that warps its growth and destroys all its beauty. De France assigned it to a separate genus, *Hinnites*. But two living species are known; one of them is ours.

The adult shell is attached by its left valve, perhaps to the inside of an old abalone shell. Its valves are oblong with fine, irregular ribs beset with short thorns. The ears, always unequal, extend in two-lobed, shapeless flaps from the beaks. The valves attain surprising thickness; the sculpture becomes coarse and the colour fades. Two things survive the wreck of time. The oldest, most battered veteran the waves cast ashore shows still unimpaired at its hinge the perfect little infant shell, with a distinct boundary set when the erratic life began. The second striking character is the bright purple colour about the hinge area inside. This spot appeared when the free life ended, and it broadened and brightened as age increased. Length, 3 to 5 inches.

Habitat.—Pacific coast.

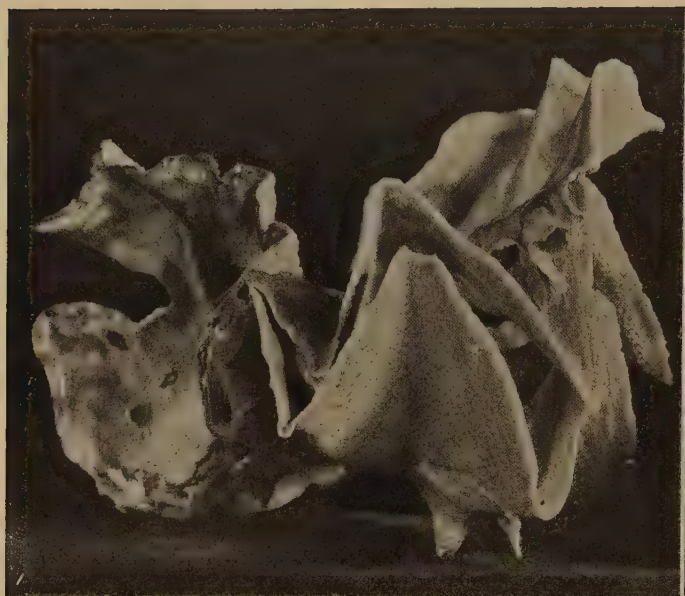


SCALLOP SHELLS

1 Knobbed Scallop, *Pecten nodosum*.

2 Purple-hinged Scallop, *Hinnites giganteus*.

3 Crusaders' Scallop, *Pecten Jacobaeus* (a pair open wide).



OYSTERS AND JINGLE SHELLS

- 1 *Ostraea crista-galli*.
- 2 *Ostraea edule* (edible).

- 3 *Placunanomia macrochisma*.
- 4 *Anomia ephippium*.

- 5 *Anomia enigmatica*.
- 6 *Anomia glabra*.

CHAPTER XXXIII: THE JINGLE SHELLS

FAMILY ANOMIIDÆ

SHELL thin, hyaline, flattened, usually warped, with a large, deep notch for the byssus in the under valve, near the hinge; byssus large, short, calcified, permanently fastening the mollusk to a rock fragment or a shell. Mantle open, except at hinge, border double, fringed; eyes wanting; gills four, large curved; foot dwarfed, finger-like, grooved; sexes distinct. A highly specialized family, with the organs displaced to accommodate the unique location of the byssus.

Genus ANOMIA, Linn.

Shells roundish, translucent, pearly lustre within the unequal valves; upper valve convex, lower, concave. A small genus widely distributed. The species are hard to distinguish, as individual shells are modified in shape by the foreign bodies to which they become attached. Changes in shell characters are also due to increasing age and varying depths.

The **Smooth Jingle Shell** (*A. glabra*, Linn.) is one of the most familiar and abundant shells on the American beaches, east and south. The upper valve is the one that is washed ashore after the mollusk dies. Ask any shell-gatherer on the sands to show his hoard to you, and a fair proportion of the shells, especially if you accosted children, will be the dainty "golden shells," tinged from yellow to salmon pink, or the pale, lustrous "silver-shells," like them except in colour. When you shake them, or run your hand down into a lapful of them, they clink musically, and though they look fragile, they do not break easily. New Jersey beaches have a bluish-black form, an inch in diameter.

The jingle shells when young settle upon some rough surface — an oyster will do nicely, or the hollow side of an empty scallop. If there is n't room for all, they cheerfully pile themselves, one upon another, each firmly riveted to the one below by the limy

The Jingle Shells

byssus. Oyster dredges often bring up masses of jingles alive, shells all ajar. A tap on one of the outer shells causes it to close tight. As if signalled, the next one follows suite, then the next, until in succession they all sense the danger, and are safely locked in.

Pretty lampshades are made by piercing the valves near the hinge and stringing them, then attaching the strands so as to fit over the outside of a plain glass or porcelain shade, whose brightness is pleasantly mellowed by the network of shells. Such an article is especially appropriate in a seaside cottage. Portières of strings of shells are hung in doorways and draped over windows. To make so elaborate an affair takes tremendous energy, and robs the shore of treasure that belongs to all. The results of such zeal are likely to be disappointing.

In the aquarium the living *Anomia* thrives and is a pretty and interesting tenant. The shell is never so exquisite as when alive. Length, 1 to 3 inches.

Habitat.—Atlantic coast.

The **Saddle *Anomia*** (*A. ephippium*, Linn.) is so much like our species that it is by some authors considered identical. The type form has a rounded outline, slightly oblique, and irregularly striated, sometimes scaly and yellowish white. So variable is it that no less than thirty specific names have been applied to forms now assembled under the name Linnæus gave. So confused was the great man with this protean group that he called it *Anomia*, "nameless," as no descriptive designation would fit shells which mould their shapes to objects on which they grow. In France these are used as food. Diameter, 2 inches.

Habitat.—Europe.

The **Prickly *Anomia*** (*A. aculeata*, Linn.) occurs with our eastern species, from which it is easily distinguished by its small size and the prickly scales on its upper valve. It is found attached to stones.

The **Lamp *Anomia*** (*A. lampe*, Gray) is smooth and thin and shining yellow, a saucer with an arched lid through which a wick protrudes. The resemblance to an ancient lamp thus struck Mr. Gray. Like its relative, it assumes various shapes, which earns it the name, "the lawless shell." Length, $\frac{1}{2}$ inch.

Habitat.—Southern California.

The **Port Essington *Anomia*** (*A. elyros*, Gray) is the finest species in the genus. The valves are thick, opaque white, square

in outline, the upper valve tinged rusty, the lower greenish. A thick callus surrounds the byssal aperture inside. Diameter, 3 inches.

Habitat.—Australia.

The **Noble Anomia** (*A. nobilis*, Rve.) wears obtuse scales on the distant ribs of the greenish white upper valve. The lower one is a rich turquoise blue. Length, 2 inches.

Habitat.—Hawaiian Islands.

Genus **PLACUNANOMIA**, Desh.

The Western **P. macrochisma**, Desh., has a large, arched upper valve, rough, and irregularly ridged outside, brilliant, iridescent green inside. The flat under valve is far too small to meet the rim of the upper one. The byssal aperture is much larger than in *Anomia*. A muscle scar curiously rayed is visible through this hole. Though normally circular, the shell is very irregular in growth. The flesh is bright orange and very good eating. Diameter, 2 to 4 inches.

Habitat.—Pacific coast of United States.

CHAPTER XXXIV: THE WINDOW SHELLS

FAMILY PLACUNIDÆ

Genus PLACUNA, Sol.

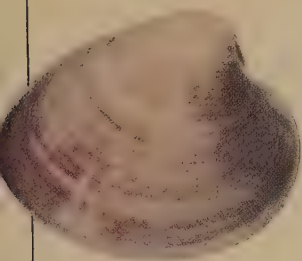
SHELL bivalve, pearly, of flattened, round, laminated, radiately striated valves; hinge ligament exterior at beaks, running inward in two divergent grooves. No byssus; muscle scar double, large. Animal very much like *Anomia*. Four species in China and Australia.

The **Saddle Oyster** (*P. sella*, Lam.) begins life with flat, round, transparent valves, but as it grows the margin becomes more wavy, attaining when adult a curvature that imitates the arch of a saddle. The added laminæ take on a purplish colour which reflects, inside and out, a pinkish pearly lustre. Half-grown shells are beautifully mottled and semi-transparent. Length, 6 inches.

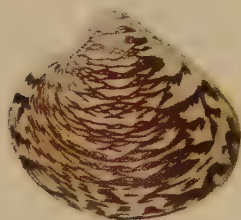
Habitat.— Coasts of China and India.

The **Chinese Window Shell** (*P. placenta*, Linn.) has flat, circular valves, lying so close as to crowd the animal if it is much thicker than a sheet of paper. They are translucent, faintly rosy-rayed when young, with a yellowish lustrous surface and a gentle curvature of the ventral margin when full grown.

The laminated structure of these shells permits of their separation into thin sheets, as in the mineral mica. The Chinese have long used these sheets in lieu of glass for window panes. Specimens of the young shells may be obtained in curio stores. Soaking loosens the thin laminæ that compose them.



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BIVALVE SHELLS OF TROPICAL SEAS

- | | |
|---|--|
| 57 Humped Callista, <i>Callista umbonella</i> , Lam. | 61 Venus Callista, <i>Callista erycina</i> , Linn. |
| 58 Tiger Cytherea, <i>Cytherea tigrina</i> , Lam. | 62 Grooved Tellen Shell, <i>Tellina striata</i> , Chemn. |
| 59 Purple-streaked Cytherea, <i>Cytherea pelechialis</i> , Lam. | 63 Violet Soletellina, <i>Soletellina violacea</i> , Desh. |
| 60 Keeled Wedge Shell, <i>Donax carinata</i> , Hanl. | 64 Rayed Galathea, <i>Galathea radiata</i> , Lam. |
| | 65 Lettered Carpet Shell, <i>Tapes litterata</i> , Linn. |

CHAPTER XXXV: THE OYSTERS

"Hech, sirs! but the month o' September's the month after my ain heart — and worth ony ither two in the year — comin' upon you, as it does, after May, June, July and August, wi' its R and its Eisters — ilka shell as wide 's my loof — ilka fish like a shot-star — and the tottle o the whole swimmin' in its ain sawt-sea liccor."—*Noctes Ambrosianæ*.

FAMILY OSTRÆIDÆ

Genus OSTRÆA, Linn.

SHELL irregular, of unequal valves, the left one larger, convex, and cemented to a support; hinge line thick, without teeth; cartilage pad keeps valve open; animal without byssus, foot or siphon; mantle with double fringed border, and "eye-spots"; adductor muscle single, near centre of shell; heart in front of rectum; gills four, concrescent with mantle. A single living genus, with about fifty species, including the most important of economic mollusks, the oysters of commerce.

The **Edible Oyster** of Europe, (*O. edulis*, Linn.) is round in outline when young, but it becomes very much distorted as it grows. The concave left valve which is cemented to the support has marginal scallopings and shingled plaits or spines on the surface. The flat or concave right valve is smooth, as a rule. The individual is hermaphrodite, both male and female. Length, 3 to 6 inches.

Habitat.— Europe.

The **Virginia Oyster** (*O. Virginica*, Lister) is the North American species whose cultivation centres in Chesapeake Bay. Its form is irregular, elongated, with coarse, dingy exterior of limy shell layers, and polished but not pearly lining. The scar on each valve marks the place where the strong muscle is attached. Sexes distinct. Length, 6 to 15 inches.

Habitat.— Atlantic coast.

Some authorities recognise a second, deeply scalloped species, on northern shores, and designate it *O. borealis*. In all probability it is but one form of the protean *O. Virginica*.

The Oysters

The growing oyster-beds about San Francisco Bay are stocked with *O. Virginica*. "Seed" as large as a silver quarter is shipped in barrels across the continent, packed in damp seaweed. They illustrate the oyster's tenacity of life, for they live and grow and fatten for market. They spawn freely, but the young die, probably because the water is too cold.

The **Lurid Oyster** (*O. lurida*, Cpr.) a native of the Pacific coast, is small and has a thin purplish shell. It varies from round to oblong. Its flavour is indifferent. Length, 2 inches.

Habitat.— Puget Sound to California.

The **Tree or Coon Oysters** (*O. frons*, Linn.) are found growing together, forming masses as big as a bushel basket hanging from the supple aerial roots of the red mangrove in southern Florida, and built into the rocky breastworks of many a coral beach. They extend to North Carolina. The individual oysters are small, with thick, rough, shapeless valves. It is surprising that it pays at all to open them. Yet I recall a most delectable stew made of this strange fruit of the mangrove tree. Raccoons feed upon them with avidity.

Of many species of oysters I make no mention. In spite of frills and plaits they are recognisable as oysters. The Chinese cultivate at least one species. There is a rumour of a Japanese oyster that measures a full yard in length. Its flesh is said to be disappointingly tough.

The *Oyster's Anatomy*.— The oyster is, to the average mind, a formless mass of succulent tissue, shaped by benign Providence to descend with ease "into the eager and expectant tomb." That is because anatomisation is a laboratory process, and we are accustomed to meet the oyster only at meal-time. As a living creature it is wonderfully made. Take a freshly-opened oyster of good size and examine it with care, you will soon forget that it is edible.

That enveloping web is the mantle; between the oyster and the shell this protecting garment lies; its surface secretes the shell. See the cut stub of the adductor muscle in the middle of the body. By it the two shells were bound together in life. Lift the delicate mantle, and you see two thin, semi-circular leaves, free at their outer borders. These are the gills. Under them lies the central body mass; a second pair of gills is under it, and another mantle fold. On the hinge side of the muscle

is the heart. In a live oyster you may see it beat! Forward of the gills are two small flaps, the palpi or lips. Between them the large mouth leads to the stomach and intestine. After winding through the body substance this alimentary tube ends in the mantle cavity just above and behind the adductor muscle. The dark mass surrounding the stomach is the liver. The kidneys and reproductive organs lie close to it, in the body mass.

Normally, an oyster lies with its two valves slightly ajar. Note the rubbery ligament inside the hinge. When the oyster hears a noise or sees a shadow that suggests danger, the adductor muscle contracts, pinching the ligament and shutting the shell tight. It cannot stay closed long at a time.

There is a constant current of water flowing into the front of the shell, between the mantle and the body, bathing the gills. This vigorous current is produced by microscopic cilia (hairs) that cover the gill surfaces, and have the strange property of moving rhythmically with oar-like stroke, all acting in unison. The water passes through small pores into the tubular substance of the gills, where the blood is oxygenated.

Food particles, with which the seawater is laden, are wafted along between the gills, but they do not enter the pores. They accumulate in windrows just outside, and reaching the lips, they are urged on by labial cilia into the mouth. Thus an oyster feeds as it breathes.

The oyster's eyes are obscure pigment spots in the mantle margins. Feeling, a well-developed sense, is also located in the mantle. Knots of nervous matter connected by threads constitute the oyster's simple nervous system. This is all a headless, footless mollusk needs.

The "beard," which certain oyster recipes require to be removed, is the gills. The "heart," so-called, is the adductor muscle.

Life History.—In early summer an oyster's gill chambers become gorged with a milky fluid. The females contain ova, the males milt. These two reproductive elements are discharged when ripe, and their unison (the fertilization of the ova) occurs in the water, which soon swarms with fertile eggs. It is estimated that a large oyster can produce sixty million eggs. The average is probably twenty-five million or less.

The swimming embryo is a somewhat spherical body, one-

The Oysters

loads of the little "jingle shells" (*Anomia*) to put down. Spat that settles on jingle stool becomes separated by the disintegration of the thin shells in a year or two. Scallop shells are also used. Tin cans have been tried; the salt water rapidly eats through them, liberating the individual oysters. Light weight shells are liable to be washed away with their loads of young oysters by strong tides or currents. Oyster shells strung on wires and hung between submerged posts are good spat-catchers. But this plan involves too much labour. Brush and straw are used somewhat on muddy bottoms, and where currents are strong.

The Chinese have for centuries grown oysters on bamboo screens in the estuaries of rivers. The French, who have no natural oyster beds, have constructed an elaborate and successful artificial system of oyster culture, by converting worthless mud flats into *parcs* and *claires*. Here they grow and fatten oysters for the Parisian market, which is the most exacting and the best-paying market in the world.

The most perfect device for catching spat is used by French growers. Hollow tiles, coated with cement, inside and out, and piled crosswise in wire trays, are suspended between posts under water. The entire surface becomes covered with spat. In due season the young oysters are chipped off with the cement; thus separated, they develop in perfect form in trays where they are never allowed to become crowded.

In this country we still have natural beds in a productive state. Comparatively speaking, oysters are cheap and labour is dear. Conditions on the French coast are reversed. The most perfect methods of culture cannot profitably be adopted in the present state of the industry. Dr. Brooks's important demonstration that the ova of oysters can be artificially fertilised and carried safely over the critical embryonic stages, has, as yet, no practical bearing on the business.

Thinning and Transplanting.—The mangrove oyster illustrates the logical consequences of too much crowding. Spat which coats the clutch completely the first year enters upon a struggle for existence which warps and stunts the growth of all. So many feeding must often face comparative starvation.

When the spat is a year old, and the size of a twenty-five cent piece, the business of thinning and transplanting may well begin. A good "set" should furnish quantities of spat for planting

new oyster beds, profitable to the owner for extending his acreage, or in sales as "seed" to other oyster growers.

Though two oysters may be alike in size and quality, the one with a smooth, regular shell brings a higher price in the market than the rough, irregular one, which is ugly and hard to open. So growers give considerable attention to breaking up the clumps upon which the spat is attached, thus giving the individual more room, and in the end making a crop superior in form, size and flavour.

The taking of oysters for market thins the bed, and improves the conditions under which the young oysters are living. With clutch of scallops and jingles, growth of the new shells is a force that helps to break apart the substance to which they are attached. Distorted shells improve in shape when the cause of their distortion is removed.

Flavour and Fat.—Transplanting has a marked effect upon the rate of growth and upon the flavour of an oyster. These considerations are vital. There is a year's difference in the time of bringing an oyster to market on the two sides of Long Island. As many as possible are taken to Great South Bay from the Sound for this final spurt. Two-year-old stock averaging one and three-eighth inches long brought from the Connecticut shore in May attain three inches by November. Cleaner water and more room make better-shaped shells, fatter and better-flavoured oysters — hence a higher market price. "Blue Point" oysters are all grown or finished in Great South Bay, though Blue Point is but one of many villages that supply the New York market with this popular brand.

The famous French "green oysters" of Marennes are carefully fattened in ponds containing a green diatom whose pigment colours the gill fringes to the shade required by an exacting public, and gives the oyster their distinctive flavour. English people and Americans frankly dislike green oysters.

The British oyster market is supplied from beds about the mouth of the Thames and off the coasts of Kent and Essex. The Englishman prefers a five-inch "native," five years old. In New York oysters are marketed at from three years old upward.

Oysters are fattened on bran and oatmeal in cellar tanks for the Billingsgate market in London. "The flavour is all but lost in the fat." Experiments prove our oysters to fatten and

The Oysters

improve in flavour by being liberally supplied with fine corn meal. This is not practicable; the natural food supply brings the oyster to prime condition, and extra fatness is not demanded by the American market.

The best fattening grounds are often found near the mouths of rivers, in brackish water. It is true that by reason of the pollution of streams by sewage, oysters are contaminated, and typhoid and cholera sometimes develop in persons eating these oysters. "Oyster scares" are periodic outbreaks that for a time check local demand. The laying down in clean water of oysters from muddy beds greatly improves their appearance and flavour, by the thorough washing it accomplishes.

The Oyster's Enemies.— It is calculated that an infant oyster has but one chance in one million one hundred and forty-five thousand to grow up. Fish devour the larvæ in great numbers. Settled comfortably on the shell or stone that is to be its support for life, and shielded to an increasing extent by its own shell, the oyster may bid farewell to many fears that beset its free-swimming infancy. But enemies are present in great variety and numbers still. A freshet may cause deposits of mud that smother them; the currents may shift the sand just enough to bury them. Crabs many times devastate an oyster bed, as if by concerted action, crushing all young shells up to a year old with their powerful pincers. The starfish, ray and octopus do great damage. Drills (*Urosalpinx*) and dog whelks (*Nassa*) are enemies which bore the shells with their rasping tongues and suck out the soft parts, leaving the tough remains for the scavenger crabs and whelks. The moon shell (*Natica*) and pear conch (*Fulgur*), are charged with similar deeds, but they are not such oyster specialists as the well-hated and hotly pursued drills.

Fish consume young oysters until the shells are hard enough to resist their horny jaws. The drumfish and sheepshead menace the beds about Long Island. Menhaden and alewife are in this same predatory class.

One of the most insidious enemies is the boring sponge which honeycombs the shells so that the oyster is exhausted with sealing up punctures with new shell deposits. Often these shells crumble. They form stations for the attachment of sponges and hydroids, which smother the oyster, and rob it of food.

The starfish begins its ravages upon oysters scarcely the



Photographs by Frank Overton, M.D.

THE OYSTER AND OYSTERING ON GREAT SOUTH BAY, LONG ISLAND

- 1 Emptying the tongs on the culling board.
- 2 The oyster boat, and tongs at work.
- 3 Shapely oyster attached by a drill.

- 4 Young oysters attached to a twig.
- 5 Live oysters as they come up in the tongs or dredges.



MASSSES OF COON OYSTERS GROWING ON THE AÉRIAL ROOTS OF THE RED MANGROVE IN SOUTHERN FLORIDA

Photograph by Julian A. Dimock

size of a pin head, and continues through life. It swallows the spat, and oysters up to three inches long. Its stomach is turned wrong side out, and often wrapped around the victim, which is overcome by the digestive fluids. The flexible arms clasp the oyster shell, adhering by means of their rows of sucking disks. Dr. Schiemenz believes the star actually forces apart the valves of large shells by main strength. It holds on until the victim's strength is gone, then thrusts its inverted stomach into the interior and absorbs the contents.

Starfishes go in schools, migrating from place to place, destroying the victims in their path. In brackish water they do little harm, but in outside beds destruction may be complete before the owner suspects that anything is wrong.

The "tangle," a great mop made of bunches of ravelled rope, supported on iron rods, is let down from a vessel, by davits with block and fall, and drawn across the oyster beds. Stars of varying sizes are brought up, entangled in its meshes. The best equipped boats have a trough of water heated by connection with the boiler of the engine. Into this the mops are plunged. It kills the stars; and the tangle is lowered again. With this labour and time saving device, using two tangles, alternately hauled, over one hundred thousand starfishes have been gathered in a single day. A bed is not considered safe to leave as long as half a bushel of stars can be caught in a day.

Drills are so small as to make their capture very difficult. An eye out for drills is a prime necessity in dredging and culling. The tangle gets a few, but this is incidental. A dredge with fine screen sides and bottom, and lid of inch mesh screen has a sharp iron lip. Dragged along the bottom, this scoops up everything that is loose; the drills and other small debris fall into the dredge, the coarse material passes over the lid, and is left behind. The dredge is drawn up, and the drills destroyed.

In any dredging many young oysters are destroyed. But dredging for enemies is the lesser of two evils.

Crabs are a formidable oyster enemy in Chesapeake Bay. They are also profitable shell fish; so they are permitted to live until of marketable age, though they cause great damage to the oyster beds. A tangle takes them up in great numbers.

The sting ray or "stingaree" menaces the oyster beds in San Francisco Bay. To exclude this enemy palisades of stakes

set four inches apart fence in some of the beds. The oyster *parcs* of France have leafy branches, called *pignons*, interlaced in the gates that close the canals, to frighten away skates and devilfish which might enter when the beds are flooded by the tide. It is necessary to go over oyster beds with dredge and tongs to take up debris such as seaweed that has drifted in, and threatens to smother the young oysters.

This truth is evident : a stretch of sea bottom favourable for an oyster colony encourages colonisation by various other marine forms of life, animal and vegetable. The oyster farmer must fight nature as the grower of corn or cabbages wages war upon weeds and insect enemies.

The Oyster Harvest.—Oyster beds are owned or leased, according to varying state laws, and there are public beds where anybody having a local licence may fish. No general fishing is allowed in summer, nor may anyone ever fish by night. The size and type of vessels and tools to be used are regulated by law. Private owners and lessees are careful that the boundaries of their beds be respected. These boundaries are marked by stakes in shoal water; in deep water by buoys. A public or private police force (often both) restrains illicit fishing. Public sentiment is strongly against law-breakers.

Shoal beds are usually fished from small boats: canoes in Chesapeake Bay, "sharpies" in Long Island Sound, dories on the New England coast. The tools used are two-handed tongs or "nippers." Each boat employs two hands, usually a man and a boy. Deeper water, especially in exposed regions, requires larger boats, more men, and more elaborate machinery for getting the oysters. Dredges are forbidden by law in some states; steam vessels and machinery are forbidden in some. Tongs with handles thirty feet long can reach bottom to four fathoms depth. After this, dredging is necessary. The heavy dredge is very destructive, but many private companies operate steam dredges, with large crews of men, the most rapid, if the most wasteful, mode of taking up the crop. The small-toothed rake dredge is less efficient but less destructive.

The small fisherman thrusts his tongs down over the boat's gunwale and by working the two handles back and forth a bit he manages to gather a load of *something* from the sea bottom, between the two sets of inward-pointing teeth. The two arms

cross just above the rakes and so act like a pair of long-handled pincers. Up he hauls his load and dumps it in a broad trough. He hauls again and again, then stops to "cull" his trough. The few oysters go into a basket; the rubbish, including dead shells, etc., set with young spat, is thrown back. A bushel or two of oysters from the public beds, product of a day's work, satisfies the small fisherman. They will bring him two to three dollars, carted about the town, and furnish him a stew for supper beside. But there are many stormy days when he can't go out. The public beds are becoming fished out.

The dredges are scoop shovels that drag the bottom, and when full are lifted, dumped in the vessel, and lowered again. The culling waits until the vessel is in and the cargo discharged. The shells and other materials suitable for "clutch" are thrown into a pile. The oysters are sorted; the spat is put aside to be laid down again, and objectionable rubbish is discarded, along with oyster enemies. Culling of each dredge-load on the boat dumps back much objectionable debris. Careful harvesting involves a thorough cleaning of a bed.

The average depth of beds in Long Island Sound is five to six fathoms. Great South Bay is deeper and the outer beds cannot be fished in severe weather. Oysters from them are laid down near shore in fall and taken up for winter use, by cutting out a ten-foot strip of ice; the tongs stand on planks laid across the open water, and load their baskets into wagons standing on the solid crust.

Sorting.—Oysters sent to seaboard markets go in barrels or bags in the shell. These are "sorted" in the sheds that line the shores. I saw the process at Patchogue, Long Island, in 1906. Men sat on stools before bins filled with the oysters as they came from the dredges. Bushel baskets were close at hand on the floor for each sorter. In one he threw the small, regular three-inch oysters, the choicest sort, due to bring \$1.50 per bushel, wholesale. These are served on the half-shell. The next grade are large ones, used to fry. They bring \$1.25. Smaller ones, for general use, \$1.00. Into the fourth basket irregular shells were thrown, to be opened by the retailer, who gets them for eighty cents. Once out of the shells they are as good as any "bulk oysters." Dead shells are saved for clutch. Young oysters are planted again next day.

The Oysters

"Plumping."—The sorted oysters, duly credited to the sorter, are prepared for market by being placed, for a day or two, on floats or perforated rafts with shallow compartments, which lie in a canal cut in from the beach, but receiving fresh water drainage from the land side. In this water, which is much less dense than sea water, the oysters bloat, and take on the semblance of fatness. The gills and alimentary tract are cleansed, which is especially desirable when the oysters come from muddy beds. In actual nutrient value, the oyster loses about 13 per cent. It gains from 12 per cent. to 20 per cent. additional weight by reason of the water it absorbs.

Herein is exemplified the truth expounded by P. T. Barnum. The American public prefers the bloated oyster, insisting that it is fat. Take an oyster out of its ocean bed and put it into distilled water. It will "fatten" in a short time, and some of its protein, carbohydrates, fats and mineral salts will be found by analysis in the water.

Left too long on the floats the oysters become lean and tough and lose flavour. So the "plumping" process is carefully timed. The canals must be very carefully guarded against contamination, or the oysters will become carriers of disease.

Shucking and Packing.—Most oysters sent inland are "shucked" in the sheds before shipment. Long lines of men and women stand in the alleys of the shed, each facing a "shucking trough" full of oysters in the shell. Two buckets holding a gallon each are supplied to each. A wooden block with a flat piece of iron set in it is to break the "bill" of the oyster on. A hammer and an oyster knife complete the equipment. One bucket is for "extras," one for oysters of ordinary size. Men with wheelbarrows replenish the troughs at the foreman's orders, and remove the accumulating shells from the floor.

The shucker may open the shell with a skilful thrust of the oyster knife. This "stabbing" method cuts the muscle, and liberates the oyster with a single motion. The other method is to lay the thin "bill" of the shell on the iron projection on the block and knock it off with the hammer, before using the knife to cut the muscle.

The shucker empties his bucket into a trough, and receives his tally check for it. The stream goes through a partition, and into the "skimmer," a vat with perforated bottom, which drains

off the liquor. Bits of shell are removed and the oysters are measured. They are next put into large receiving tubs, whence they are taken, a few gallons at a time, and thoroughly washed in the "cullender." Now they are put into flat quart cans, kegs, barrels or tubs. Ice is freely used after the closing of the receptacles. Cans packed along with cakes of ice in sawdust are shipped inland and keep perfectly.

Cove Oysters, familiar to all who have studied the grocers' shelves in small inland towns, come from Chesapeake Bay, chiefly. These small-sized oysters are steamed before being "shucked"; cars six or eight feet long run from the wharf directly into the "steam chest," and after the steam has been turned in for fifteen minutes, out again, to the shucking shed. As soon as cool enough to handle, the gaping shells are quickly divested of the meats, which are thrown into large cans. These cans are removed, the oysters washed in ice water, then thrown out on long tables where the "fillers" pack them into small round tin cans, which are set in iron racks, and immersed in the "process kettle" where the oysters receive their second steaming. Now they are cooled and sealed, labelled and boxed for shipment. When the business is in full swing, an oyster finds itself hermetically sealed up in an hour after it is taken out of the water.

September is, in England and France as with us, the month in which the oyster season opens. Oysters are in best condition in November, tender, fat and fine flavoured. The season coincides with the R months on the calendar. May ushers in the spawning period, which covers the summer months. During this time the oyster is flabby and tasteless, but not poisonous.

A writer in the *Nautilus* declares the North Island of New Zealand to be "the chosen paradise of oyster eaters, for there the oysters are not only delicious, but ridiculously cheap." The rocky inlets about Auckland are built up with masses of oysters. The Maoris come from far and near every summer to feast on them for a time. They are very skilful in breaking the clusters and opening the shells.

Stewart Island oysters are famous in the markets of Australia and New Zealand.

They are large, symmetrical and of rare flavour. Queen Charlotte Sound in the middle of New Zealand furnishes oysters with a decided coppery flavour, very popular where they are

The Oysters

known, but something of a trial to newcomers unaccustomed to this taste.

The biggest edible oysters in the world are found at Port Lincoln in South Australia. They are as large as a dinner plate, and of the same shape. I have seen them more than a foot across. It is a new sensation when a friend asks you to lunch at Adelaide, to have one oyster set before you, fried in butter with egg and breadcrumbs. But it is a pleasant sensation, for the flavour and delicacy of the Port Lincoln mammoth oysters are proverbial in that land of luxuries.

Your true oyster connoisseur, nowadays, as always, will hold to the dogma that an oyster should be eaten raw ; that no sauce nor seasoning is equal to its own "sawt-sea liccor." Yet the number of oyster dishes devised by ingenious cookery experts is legion. Here is one from a famous musician who divided his time between his piano and his saucepans, and always ate his oysters in silence and with one hand over his eyes, that his meditations might not be disturbed:

The Breton Way of Cooking Oysters. Having selected some oysters of the largest size drain off the liquor in a fine cloth, and when dry dredge them lightly with flour. Then cut up two or three large onions very small, put in a saucepan a bit of butter, and when it melts put in your onions. After they have been there two or three minutes add the oysters, and simmer them gently, seasoning with salt and pepper as they are in progress. When slightly browned take them off the fire, suffer a few drops of vinegar to moisten them, and then . . .

Another devotee gives this "final receipt" for oyster patties:

With plenty of cream let veal sweetbreads divide the honour with succulent shell fish, giving an equal portion of each, and sprinkling sliced truffles over the compound before you fill your paste. *I refrain from saying more.*

PART V
THE CEPHALOPODS

CHAPTER I: THE MANY-ARMED MOLLUSKS

CLASS CEPHALOPODA

HIGHLY organised marine mollusks, of carnivorous habits, moderate to large size, and of great strength and swiftness of motion. Shell absent, except in *Nautilus*. Body cylindrical or bag-like, bilaterally symmetrical. Head encircled by arms or tentacles which are furnished with sucking disks or hooks. Mouth fitted with horny beak, and toothed radula. Ink-bag present, except in *Nautilus*. Funnel expels water from mantle cavity and propels body backward through the water. Respiration by gills. Skin contains pigment spots by which colour of body is changed at will. Reproduction system complex. Sexes separate. Hectocotyliised arm in male contains spermatophores. Organs of smell and of hearing present. Eyes complex. Foot modified into tentacles and siphon. Nervous system centralised; main ganglia protected by cartilaginous case.

This "head-footed" group of marine animals are so different in their external character from the univalves and bivalves as to raise this serious question: "Is it not all wrong to class them with the mollusks?" With the exception of the *Nautilus* no modern cephalopod has an external shell such as snails and clams have. Instead, there is in a large proportion of the group an internal shell, familiar to us in the chalky "cuttle bone" of *Sepia* and the transparent "pen" of the squid. The complicated eye, the highly organized nervous and reproductive systems, also suggest relationship with vertebrates.

The predatory life led by these mollusks, their remarkable strength, agility and skill in running down their prey and in escaping enemies, the wonderful mechanism of the funnel, the button-and-button-hole system that opens and closes the mantle chamber in certain genera, the sucking disks, retractile hooks, and cushions on the arms of others, all give proof of high specialisation.

But the alimentary system, the beak and rasping, toothed tongue, the siphon and mantle and gills are all molluscan char-

The Many-armed Mollusks

acters. So are the circulatory and excretory systems. Though isolated far from the other members, they are mollusks.

Geologists have found a most thrilling history of the gigantic prehistoric cephalopods written in the rocks. Regarding the forms which had no hard parts, much is left to conjecture, but the shell-bearing cephalopods are in evidence, remarkable in variety, size and numbers, from the Upper Cambrian rocks, through the Silurian, Devonian and Carboniferous eras, culminating in the Mesozoic time, and dwindling in the Cenozoic.

Silurian rocks yield fossil "straight-horns" fifteen feet long. The gigantic Ammonites, with coiled and chambered shells four feet in diameter, mark the maximum point of development reached by the ancient tribes of Cephalopods. In the eras following the Cretaceous, which saw this wonderful tribe decline, the mollusks are distinctly modern in size and genera.

A brief account of these fossil cephalopods will be found in any text-book of geology.

Cephalopod mollusks are divided into two orders, based upon the number of gills and presence or absence of an external shell. Subdivision into sub-orders is based upon the number of arms that surround the head. A simple key will set forth these groups.

KEY TO THE ORDERS AND SUB-ORDERS OF CEPHALOPODS

- A. Shell internal or absent ; arms, eight to ten ; gills, two.
 - Order DIBRANCHIATA
- B. Arms eight, all alike ; suckers fleshy ; shell absent.
 - Sub-order OCTOPODA
 - Eight-armed Cephalopods
 - The Argonauts
 - The Devil-fishes
- BB. Arms ten, two elongated; suckers with horny rims; shell internal.
 - Sub-order DECAPODA
 - Ten-armed Cephalopods
 - The Spirula
 - The Cuttles
 - The Squids
- AA. Shell external ; arms, more than ten ; gills, four.
 - Order TETRABRANCHIATA,
 - The Chambered Nautilus

CHAPTER II: THE ARGONAUT. PAPER NAUTILUS

FAMILY ARGONAUTIDÆ

Genus ARGONAUTA, Linn.

SHELL a flat, roundish spiral, four to eight inches across, unchambered, ship-shaped, with double keel; ornamented with knobs and swollen veins; thin, porcellaneous, whitish, tinged with yellow: secreted by broad ends of dorsal arms, and held by them; not a true shell but an egg cradle; no muscular attachment. Male about one inch long, destitute of shell, third arm on left side hectocotylised, becoming detached and left in mantle of female at breeding time. Female large, with eight arms; suckers stalked. Distribution, all tropical oceans, and extending to latitude forty degrees north and south. Shells much in demand among collectors. Five species.

The Argonaut or **Paper Nautilus** (*A. Argo*, Linn.), has the characteristics of the genus, and is the best known species. Diameter, 6 to 12 inches.

Habitat.—Tropical and warm seas.

The two cephalopod mollusks with external shells were observed centuries ago sailing about in their graceful boats, and each was called Nautilus, which means "little sailor." One has a pearly shell; the other a white one, thin as paper. So one was called the Pearly Nautilus, the other the Paper Nautilus.

The pearly one was rarely seen. But as summer came on, fleets of the paper nautili appeared off the Mediterranean coasts. Writers of Greece and Rome called them Argonauta, an allusion to the fabled Argonauts, who, under Jason, sailed away to find the Golden Fleece.

Now, is n't it strange that a large and conspicuous mollusk like Argonauta, sailing all warm seas, appearing by hundreds close to shore where men could pick it up and make its acquaintance, should have kept the secrets of its ways of life so long

from inquisitive mankind? As late as 1850 little more was known about it than Aristotle wrote four centuries before Christ.

The ancients noticed that the shell has no muscular attachment to the body. The mollusk relaxes its hold when handled and the shell slips away. Wise people said: "Here we have a parasite like the hermit crab, that has picked up a shell and moved into it." But nobody could clear up the mystery of the shell. Where and what was the mollusk to which it rightfully and originally belonged? Nobody could say with certainty. Nor could anybody say whether the ship-wrecked Argonaut could live without the shell. Nobody ever saw a male Argonauta. The specimens seen were all females.

About the middle of the nineteenth century scientific interest in the paper nautilus reached white heat. Two of the leading zoölogists of the time tried to convince all the rest that the argonaut has no means of secreting a shell. They believed the shell to be that of a large sea snail. The arguments upholding these theories were very clever, but facts were lacking.

Another mystery appeared for solution. A long, wriggling, whip-like object was found hiding in the folds of the mantle. It looked like the arm of an octopus, and was full of spermatozoa. Some authors believed it to be a parasite; others jumped joyfully at the conclusion that at last they had found the male argonaut.

While these men argued, a lady at Messina, Italy, was closing a long series of observations on the development of Argonauta. It is not difficult to keep the eggs in a marine aquarium and to watch the young ones grow up. Madame Jeannette Power saw the eggs hatch perfectly formed and very active young, which exhibited no sign of a shell. In ten or twelve days the shell was observed to be forming in some individuals.

This shell is a strange and unusual one. It is not truly a shell at all, but a cradle secreted to protect the eggs in the breeding season. The male has no shell. The shell glands of mollusks are in the mantle edge. Here is a unique exception. The two dorsal arms spread out into large webs at their extremities. These two thin "vela" have the shell glands; the mantle has none. When the young female is one inch long it begins to form a shell. The body rests in the mouth of the shell, though it extends pretty far out of it, and the two inflated web-like arms always clasp the two sides of the shell tightly, and deposits of

shelly substance are constantly added. Serious breaks in the delicate porcelain shell are repaired by this web; the strangest recorded incident is of the cementing in of a broken piece, but wrong side out.

There is no union by muscle bands between shell and body. The arms simply hold it fast, and in such position that the eggs from the beginning are protected by being lodged in the coil of the shell, with the body between them and any harm.

The report of Madame Power's investigations was made by Professor Richard Owen before the Biological Society of London in 1839, and the question of whose shell the Argonauta lived in was settled once for all. The cause of science took a mighty step forward. For this quiet student proved that observation, not argument, is the straightest road to truth.

Fourteen years later, in 1853, Müller identified and published a full description of a tiny octopus, the male of Argonauta. Investigations of an earlier date had just demonstrated that the supposed parasite in the mantle cavity of the female is one of the eight arms of the male, modified as a bearer of the spermatophores. The arm ends in a whip-lash. In this is a passage through which the spermatophores pass out into the mantle cavity. A kind of spring in each spermatophore is released, scattering the dart-like spermatozoa over the exposed ova. Union of sperm cell with ovum cell is called "fertilisation." Now the nidamental glands pour a viscid substance over the eggs, which hardens, forming a series of globular capsules, all joined together into a compound cluster, like a bunch of grapes. The useless hectocotylised arm is now discarded. The egg cluster is crowded back into the spiral. Gradually its increasing size crowds the mollusk out of her seat. Then the egg mass, still firmly attached to the body of the female, floats upward in the water, until the young hatch and swim off as free individuals.

When the fragments of evidence were brought together they fitted so well that scientists wondered greatly at their own stupidity. For had not Aristotle told them that the polypi of the Mediterranean had one arm swollen and distorted at the breeding season? Even the fishermen knew this. We now know the hectocotylised arm to be a constant character among all cephalopods except the pearly nautilus. In only three genera, however, is it detached.

Picture the meek little eight-armed beast offering his hand to the lady Argonauta of his choice. She accepts it literally, snatches it, and swims away with it ; and that is the last he sees of her. He does not accompany her to the surface of the water.

Good sailors they must be, the argonauts, to have become distributed so widely over all warm seas. They are reported to be very plentiful on the northern coasts of Australia where they are cast up by winds during spawning season. The sea gulls devour them and their eggs, and the empty shells are carried off by the returning tides. Live argonauts are reported occasionally on the Florida coast; they abound among the Pacific Island coasts, in the Gulf of California, and about the Cape of Good Hope. Deep sea dredging brings them up most anywhere within 40 degrees of the equator. Fresh shells were taken up ninety miles from Narragansett Bay, R. I. A single specimen came ashore at Long Branch, N. J., and was studied alive for ten days in an aquarium.

For most of the year the Argonaut walks about on the sea bottom, carrying her shell aloft, still in the sure clasp of those two wing-like arms. To conchologists her life history is full of interest and charm. To poets and to all but the literal-minded she will always be:

“The ocean Mab — the fairy of the sea,”

her fragile shell a dream ship, with purple sails, companion of the ship of pearl, the Chambered Nautilus.

CHAPTER III: THE DEVIL-FISHES. OCTOPI

FAMILY OCTOPODIDÆ

HEAD very large; arms eight, long, all alike, more or less webbed; suckers usually in two rows; mantle supported by columns or bands of muscle.

Genus OCTOPUS, d'Orb.

Body much shorter than arms; suckers few, in two rows; arms extensible, large, webbed at base; third right arm hectocotylised; two cartilaginous stylets stiffen the back of mantle.

Octopus, Devil-fish. Polypus. (*O. vulgaris*, Lam.) Marine, carnivorous mollusk, of great strength. Body globose or pear-shaped, six inches to one foot long, with scattered horns on back; arms smooth, sessile, uniform, fleshy, elastic, webbed at base, three or four times as long as body; suckers not stalked, set in two rows on inner face of arm; neck short, small; head large; eyes prominent, with horn above each; skin dusky, but varies from purple to yellow and white; hectocotylised arm short, broad, flat at tip, whitish, with one or two suckers abnormally large; eggs small, clustered on a central cord. Habits, nocturnal, solitary, predatory, fighting when disturbed. Food, crustaceans, bivalves and fishes. Used as food in Mediterranean countries.

Habitat.— Rocky bottoms in shallow water. Temperate and warm seas.

This is the common octopus or devil-fish of Europe, known as "Polypus" by the ancients, and accurately described by Aristotle. It lives along rocky shores of moderate depths in tropical and temperate oceans, making its home in some suitable crevice hollowed out like a grotto, where it lies with arms and web outspread ready to entrap any bivalve or fish that strays within reach of the arms. The peculiar power of taking on a colour to harmonise with the surroundings is well developed in the octopus. Its body might well be mistaken for a part of the

rocks against which it clings, and the coiling arms for the tortuous stems of seaweed on the ocean floor. The watchful eyes and the sensitive tentacles combine to bring good hunting every day to the hungry ogre, the doorway of whose cave is strewn with the bones of victims.

When no longer hungry the octopus walks abroad, sliding along the sandy bottom with all its arms flattened, the bulbous body carried aloft. Warm, quiet waters favour the propagation and general well-being of these creatures. A cold winter sends them to deep water. The spawning time is the late winter season, when the number greatly increases in the shallow water. They come in shoals or schools during January, February and March and the fishermen catch them by various means to prevent as many as possible from spawning. Though a valuable sea food in many localities, especially on the Mediterranean, in others they are counted not fit to eat, and are very destructive to the lobster and crab industry, also killing young fish so extensively as to diminish the value of the fishing industries on some coasts.

Very little is known about the rate of growth and the age of octopi. Specimens with arms three feet long are estimated to be three or four years old. This fact is quoted from the report of the Marine Biological Laboratory at Plymouth, England, published in 1899.

It is interesting to get a glimpse of the life of the octopus by watching one in captivity. Many public aquaria maintain octopus tanks. The inmate sits in a squat position, his eight arms spread out on the bottom and singularly like the rocks in colour. The body looks like a great swollen pear. The head is not unlike an elephant's, though the cruel, malignant eyes are larger.

The keeper comes to feed the octopus. A crab is dropped into the water. It seems to shudder and to realise its fate, as it settles. The octopus evidently sees and understands. The moment the crab is dropped into the tank he spies it and rushes out, his tentacles spread forward to form a hollow cone. Into the web at the base of the arms the crab is drawn. If its struggles lend any difficulty the umbrella-like cover is thrown over it, and that is the last to be seen of it. It is quick work, the tearing of the victim limb from limb. The octopus has the good taste to conceal the process from the public gaze.

It is the experience of keepers of aquaria that the curled octopus, *Eledone cirrosa*, is never safely put into a tank with *Octopus vulgaris*. A fierce cannibalistic zeal consumes the latter, and he consumes every specimen of his more gentle-mannered cousin. Even larger individuals than himself are attacked and destroyed. He apparently recognises his relative as a non-resistant, and fears no opposition.

It is in his conflicts with man himself that the octopus earns the name of devil-fish. The cruel, vindictive expression of the eye seems to be a true index to the spirit with which the animal comports itself in combat with mortals. Fishermen dealing with octopi always carry axes to cut loose the arms if they are fastened on the boat. The power exerted by the suckers is tremendous. An octopus with a few of its arms holding on to the rocks has a few free with which to seize a swimmer. It is easy to bind him hand and foot, An over-reckless man is often drowned in two or three feet of water, overpowered by an octopus with arms of four feet spread and a body scarcely as large as his fist. Scientists without experience of this cephalopod tempt death in an effort to "collect" specimens of this sort, and need help to prevent the octopus from collecting a man. "Mansucker" is one of its local names. It treats all victims alike, except that it picks the bones of vertebrates.

Denys Montfort describes an encounter between an octopus with arms three feet long and a great mastiff whose courage and strength had overcome a wolf which attacked his master. The dog first ran around the devil-fish trying to seize its arms; but the creature skilfully withdrew each in turn, and used them to lash the dog over the back as if with whips. The angry dog at length got hold of an arm, but was immediately embraced by four others, which threatened to strangle him. The octopus started toward the water, its helpless victim howling piteously and the colour of its body changing from purplish to red. It made good headway, clinging to rocks as it went with its four free arms. M. Montfort here interfered, and succeeded in wrenching loose two arms from the dog's body. The octopus uttered cries like the angry growl of a watch dog. Leaving the dog it attacked the man, but was at length overpowered. Though the arms spread nine feet, the body was not larger than a small pumpkin.

One feature of the attack quite as important to reckon with

The Devil-fishes. Octopi

as the remarkable strength of the creature's arms, is the cold, sickening, slimy feel of them. The horror of a personal encounter with a devil-fish will never be made more real to those fortunate enough to miss this thrilling experience than Victor Hugo has made it in his "Toilers of the Sea." Though lacking in scientific accuracy, it is still a zoölogical and rhetorical classic.

CHAPTER IV: THE SPIRULA

FAMILY SPIRULIDÆ

Genus SPIRULA, Lam.

SHELL partially external, small, delicate, a flat, loose spiral, divided into chambers by very convex septa; lining pearly; siphuncle on ventral side of chambers; body much larger than shell; head large; eyes prominent, arms ten, short, set with sessile suckers; tentacles not dilated into clubs at the ends; mantle folds clasp and conceal shell except at two sides; posterior end of body has terminal sucker. Habitat deep water of tropical seas.

Spirula Peronii, Lam., is the sole representative of the genus. These little shells are flung upon tropical beaches by the thousands; the Gulf Stream and Japan Current carry them far north of their natural range. Yet the creature to whom this shell belongs is almost unknown. We have it from Professor Owen and Mr. Arthur Adams that the oblong body has a sucker at its posterior end by which it holds to the rocks, while its tentacles remain free to capture food. Two backward-turning folds of the mantle clasp the shell, covering it, except at the two opposite points.

In any cabinet we may recognise this delicate spiral shell, wound so loosely that there is no union of the coils, but a gradual widening of the separation as growth proceeds. Thick septa divide the shell into chambers, and a siphuncle threads its way through each, but not in the centre, as in the *Nautilus* shell. It keeps close to the inner wall of the coil, the floor of each chamber. If ever such an animal lived in the outer chamber of its shell, the animal was smaller or the shell larger than now. What possible use the shell serves I cannot imagine, unless to throw light on the progressive development of the cephalopods.

CHAPTER V: THE CUTTLE. SEPIA

FAMILY SEPIIDÆ

SHELL six to ten inches long, internal, consisting of a broad, leaf-like expanse of spongy, chalky substance, the posterior portion narrowed to a beak and made up of thin plates with air spaces between, the front portion not chambered, broadened and much thickened. Body short and broad, scarcely longer than the shell ; head short ; eyes large, with cornea complete ; arms short, with stalked, horny-rimmed suckers in four rows ; fourth arm on left hectocotylised at base ; tentacles long, contractile into pockets behind eyes ; clubs with suckers. Distribution, world-wide. Used as food and for bait.

Genus SEPIA, Linn.

The Common Cuttle (*S. officinalis*, Linn.), called also cuttle-fish and sepia, has the family characteristics and well represents this genus. This is the species which inhabits warm European waters near shore. It is a very showy object, strikingly banded, and mottled with black, brilliantly iridescent in the sun, and quick at changing colour by the manipulation of pigment cells in the skin.

The cuttle bone, on which the canary whets his beak, is a well-known object, but few would know where to go if sent to "original sources" to get one. Even if one saw them in plenty scattered on the beach after a storm — as is common on the Atlantic shores, or picked them up afloat, one is still far from knowing the secret. Watch the gulls after the storm picking up what the waves left stranded in the way of fresh meat for them. You are fortunate if you find a half-eaten cuttle, revealing intact the porous cuttle-bone. With the clue thus furnished, examine the clefts of rocks in search of a perfect specimen. It has a broad body, considerably less than a foot long, brown, cross-banded and spotted with purple, with white on the back.

A pair of flat, narrow fins edge the body all around. At one end is the head, which bears two large black eyes and a crown of eight short arms, flattened and pointed, each one black and smooth outside — white on the inner faces and studded with four rows of suckers. One on each side, directly above the eyes, are two long tentacles, slender and smooth except at their extremities which widen into spoon-shaped expanses lined with suckers. These tentacles are so flexible that when the creature desires it can draw them into pockets in the head, completely hiding them from view.

The cuttle is not a patient mollusk. It resents your poking it with a stick. You were not expecting to be sprayed with a liquid black as ink. But the cuttle is at bay, and uses its natural weapon. In the water it swims by throwing out in jets the water that continually enters the gill-chamber, and finds exit through the funnel. Beset by an enemy, the cuttle presses a button and behold! a cloud of ink darkens the water, confuses the pursuer, and the cuttle scuttles to a safer neighbourhood.

The ink of the ancients was obtained from this mollusk's ink bottle. Painters got their sepia colour from the same source. This is the genuine, original India ink, for which no satisfactory substitutes have been manufactured.

Denys Montfort, the most voluminous writer on squids, declares that although the ink-bag of Sepia is rarely larger than a man's thumb, the force exerted upon the bag throws the jet of ink six feet; and this one bagful is enough to colour black several buckets of water.

A dead cuttle does not let its ink flow freely until the body is perfectly relaxed. In extracting sepia ink commercially the Chinese pile the cuttles in vats and drain off the fluid which flows without restraint after the cuttle has been dead twenty-four hours.

Carry your specimen home in a bucket of sea water, and put it in a roomy aquarium. It will be shy at first, but on acquaintance will show its tricks freely. The use of those eight arms will be demonstrated if you drop in a shrimp after the cuttle has fasted a few hours.

CHAPTER VI: THE COMMON SQUIDS

FAMILY LOLIGINIDÆ

Genus **LOLIGO**, Lam.

BODY long; fins present, variable in size; tentacles partially retractile; pen as long as the back, slender, chitinous, feathered posteriorly, pointed in front, keeled below. Distribution world-wide.

The Common Squid, (*L. Pealeii*, Lesueur.), is typical of the genus and the family. Body long, pointed, fins broad, triangular posterior, united behind, sessile arms eight, with two rows of suckers; tentacles two, long, partially retractile, with four rows of suckers; funnel attached to head; mantle free; eyes large, black, lateral; pen horny, slender, as long as the body. Colour of skin changed at will. Uses, bait for cod and other sea fish. Ink-sac present. Food, fish. Egg cases, called "sea mops," made of long gelatinous banana-shaped sheaths, each containing hundreds of eggs, forty thousand in one mop. Enemies, fish, conger eels, dolphins, porpoises, sea birds. Length, 8 to 20 inches.

Habitat.—Atlantic coast from Maine to South Carolina.

My first acquaintance with the squid was made in Chinatown in New York. Shapeless objects of fish and flesh hung about the delicatessen shops. Dried squids were hung among the rest, and quite as repulsive-looking as the worst of them. "Enough to make a vegetarian of you for the rest of your life!"

At Woods Holl, a year later, I met our common squid alive in his native element. That I should have judged this graceful beautiful creature by the mummy of an Oriental species to which the "Heathen Chinees" had done his worst is scarcely worthy of me.

There were a great many little squids under two inches long in a floating wooden tank by the wharf and they kept together, moved by quick darts or quietly in sweeping curves — always as if one impulse controlled them all. They were like little soft

lumps of clear, gleaming semi-fluid jelly. The eyes a brilliant green, and the skin freckled over with spots of red, which became much deeper when the creature was handled. A dozen were obtained with difficulty by sweeps of a dip net for study in the laboratory aquarium. Here they not only blushed when disturbed, but spouted black ink in quantities corresponding to their sizes.

Specimens a foot long are interesting tenants of an aquarium. Poke the placid cephalopod with a stick and he blushes all over with freckles of pale red. Now he shrinks behind a gray stone, and his ruddy colour has turned to gray. Or sinking to the sandy floor of the tank he may seem to flow over the surface, a yellowish mass, scarcely visible.

The reason for these chameleon changes has been discovered. The skin has several series of pigment spots, globular in shape, each enclosed in a membrane, which is supplied with a double set of muscles, and nerves connecting all with central ganglia which control them. Each speck of pigment is flattened into quite a large patch of colour by the contraction of the muscles attached to its equator — all pulling outward at the same time. When the red spots are called out, the gray and other sets are inactive, and the squid blushes violently. This is the usual colour exhibited in the aquarium.

The capture of food is the work of the horny, cup-shaped disks that crowd the inner faces of the arms and the clubs of the tentacles. In the bottom of the cup is a flat piston on a stout rod of muscle. When the disk is applied to any object the muscular lips and saw-toothed cartilage make an air-tight contact, for the piston is raised, forming a vacuum against which the air outside presses powerfully. These sucking disks are attached to the arms by flexible stalks. An object seized is at once held by as many of these suckers as can get hold. The arms bend and shorten to bring the prey to the mouth, the lips fall back, the beak rises up and tears the object into pieces, bolting them as large as possible.

In the breeding season the fourth arm of the left side becomes hectocotylised at the tip in the adult males. The suckers in part are replaced by papillæ. The spermatophores are carried in this arm from the time they are formed until time for fertilising the ova. A single female is said to produce forty

The Common Squids

thousand eggs at once. A large proportion of squids are devoured in infancy by fishes of all ages, else over-population by squids must certainly occur.

Eating squids is not an Anglo-Saxon habit. We leave that to foreigners of very indiscriminating tastes — the Chinese coolie and the poorer classes along the Mediterranean coasts. Nevertheless, there is a small but growing class of squid-eaters among scientists well acquainted with the creature.

The squids are first drawn, to remove all the visceral organs and the eyes. They are then steamed until the cartilage of the suckers is tender. Salt, pepper and butter is the seasoning preferred. The experiment has proved a success. Squids are declared good to eat. But a bit of dialogue that followed a squid supper, goes to prove that scientists are human.

"You were at the Fish Commission last night. What do you think of squid as food?"

"It was excellent ; I enjoyed it thoroughly. But I shall never taste it again."

"Why? Did n't it agree with you?"

"Perfectly. But — it is squid! It is the idea of it that disagrees with me."

The Tahiti fisherman has a more logical mind. He is pleased when he catches a squid. "Indeed," he argues, "what can be unclean that comes out of the sea?"

CHAPTER VIII: THE CHAMBERED NAUTILUS

FAMILY NAUTILIDÆ

SHELL with few whorls, overlapping more or less ; septa simple ; siphuncle nearly central ; aperture wide.

Five fossil genera and one living genus constitute this family.

Genus NAUTILUS, Linn.

Shell a flat spiral, pearly, with yellowish outer layer, cross-banded with brown; chambers small, except outer one; septa pearly, concave; siphuncle, a membranous tube, central, passing through each septum; body, size of a fist; head conical; jaws two, strong; tentacles nearly one hundred, unlike, in four groups on thick bases; hood formed by union of two tentacles; siphon formed of two overlapping lobes; eyes large, lateral; organs of smell, small tentacles. Distribution world-wide in deep seas.

Of this genus alone, six hundred extinct species are already distinguished by fossil remains. Only six species are living to-day. Of these but one is abundant or well known.

The **Chambered Nautilus** (*N. Pompilius*, Linn.) has a large flattened spiral shell, four to six inches in diameter, which in adults has two and one-half coils. It is gracefully turned and delicately built, pearly within and porcellanous outside, the yellowish ground of the exterior marked with reddish-brown cross-bands or stripes, variously branched. Opposite the opening of the shell the coil bears a large patch of black. There is a narrow band of black lining the edge of the opening.

In New Guinea the market value of bright, perfect shells is fully appreciated. Curio-hunters will often discover that by paying a good price they have rewarded the wily and industrious native for his pains in restoring, by judicious use of paints and dyes, the faded glory of a wave-worn shell. Oftener the shell is cleaned by having all the outer coating removed, so as to show only pearl throughout.

The Chambered Nautilus

The floor of the cavernous outer chamber is of pearl, secreted by the mantle, which lies next to it. As growth extends the edge of the shell, giving more room, the body is drawn forward, and a pearly wall is formed one-half inch or more outside the last one. It is shaped like a deep saucer, with a little pit in the centre. The siphuncle, a membranous extension of the body, like a piece of delicate rubber hose, passes through all the partitions, connecting the innermost chamber of the shell with the outermost one. The siphuncle is supported and protected at each passage.

Some investigators assert with confidence that air is admitted by it to the shell chambers, and that the buoyancy thus acquired enables the Nautilus to float, and to carry the shell with ease when it walks on the deep sea bottom. Analysis shows the gas to be a little richer in nitrogen than the atmosphere, but otherwise to be much the same. "To maintain the relative weight of the growing animal and its shell with the water," is the opinion of many. The last word has not been said upon this interesting question.

The shell is brightest and most lustrous when inhabited by its living tenant. The body is white as curds, except for brown and yellowish trimmings which harmonise with the markings on the shell. Stout muscle masses attach the body to the walls of the outer chamber.

"A Nautilus shell with a cauliflower sticking out of its mouth"—thus one surprised scientist characterised the living mollusk. The extended body shows a complicated system of tentacles of varying sizes, with bases of swollen fleshy ridges which conceal the mouth. Three dozen tentacles of greatest length form the outer whorl. These each consist of a stocky, dark brown, basal part surmounted by a slender, white "cirrus" or whip, whose function is prehensile. They are the hands and feet and fins of the Nautilus. There are no suckers. The tentacles cling firmly but delicately to objects, seizing with avidity soft bits of decaying animal matter. The mantle rim twitches while the tentacles are active. When a live animal like a crab is seized, the head protrudes, the two horny parts of the beak are seen to tear the creature's tough body cover, or cut it like a pair of shears, and the rasping mollusk tongue comminutes the flesh.

Two sets of lips surround the mouth, each bearing about two dozen feeding tentacles. Two pairs of ciliated tentacles, one in front, another behind, each eye, are very active, especially when strong-scented bait is brought near. They have been demonstrated to be the organs of smell.

The dark-coloured eyes are large and simple in structure ; they look out to right and left from their stations at the bases of the tentacles, just above the rim of the shell, and forward an inch or two from the angle next to the spiral coil. The ocean bed is probably dark, and the eye of the nautilus is, therefore, of little practical use. No doubt smell is the guiding sense in hunting food.

Tropical seas near the Fiji Islands, New Hebrides, New Caledonia and the Philippines are the most populous homes of the Nautilus. So far as is now known, specimens are obtainable in the greatest numbers on the southern coasts of the Island of Negros in the Philippines, at depths between 1,800 and 2,200 feet. Some say schools of Nautili may be seen afloat. Others deny this, insisting, in spite of what sailors tell and "poets feign," that they never come up except when in a moribund condition. In this case, they appear only at intervals and solitary.

A normal Nautilus is a stay-at-home body, which forages industriously on the sea bottom, chasing its favourite quarry, the crabs, in and out among the coral rocks.

In the Philippines there is no local demand for Nautili or their shells that would justify any direct effort to obtain them. The mollusks are attracted by the baits lowered by fishermen, and blundering into the traps, they are hauled up with the legitimate catch. They are therefore, well described as "a by-product of deep sea fishing." The fishermen pay little more attention to them than the fish do. Some are eaten by the natives, who pay about four cents apiece for them. They are used as a soup meat, or simply boiled; but their flesh is of indifferent quality. Dippers are made of the shells. Vases are sometimes elaborately carved. A rude kind of spoon is also cut out for home use. A recent development is the demand for the shells in China for the manufacture of buttons and ornaments. It is reported by Bashford Dean, who spent a short time on the fishing grounds in 1901, that a Chinaman who made a tour of the fisheries clustered on

the opposing shores of Cebu and Negros was able to pick up three thousand shells for export.

An increasing number of fishermen are trapping Nautili for the shells for export. In early summer, after the windy winter season is over and a calm lies on the water, the fishing begins in earnest. June is the best month of all. The fishermen bring their fish-traps, woven bamboo splint "bo-bos" with a cone-shaped entrance, much like a live trap for rats. Daily or every few days the fisherman hauls up his traps, removes his catch of four or five Nautili by a trap door in the bottom of the cage, renews the bait and lets the traps go down again.

The field has in recent years been visited by naturalists, eager to collect this mollusk in quantity, for museums and university collections. Arthur Willey experimented with different kinds of bait, and stated in his 1897 report:

One of the surest ways of obtaining Nautili, and, in fact the method by which I have obtained most of my specimens at Lifu, is to bait the fish basket with the cooked and bruised exoskeleton of a crab, *Palinurus*, or an allied form. The strongly scented *potage* so produced is then wrapped up in cocoanut fibre, like a small parcel and then placed in the fish trap over night. There is, therefore, nothing to be seen ; but on the other hand there is something to be smelt, and by this means I have obtained as many as ten Nautili at one time.

In Paris, quantities of Nautilus shells are used in the finest cameo-cutting, and in making pearl ornaments. In India the shells are ornamented and used as drinking cups. In America they are valued as cabinet specimens. A dealer in shells in New York will charge \$2.50 to \$5.00 for a good-sized and perfect specimen. In San Francisco you need not pay so much, and you have a better stock to choose from. It is possible to get shells sawed in two, revealing the many chambers into which the spire is divided. If the surface layer of limy substance has been rubbed off by the use of a dilute acid, the shell is pearly throughout, one of the largest, most beautiful and most interesting shells to be found in any collection.

Dr. Oliver Wendell Holmes has established the Pearly Nautilus, with all the charm of myth and poetry upon it, in the minds and hearts of all English-speaking people. The ship of pearl is not more beautiful than are the lines in which the poet has described it and interpreted its heavenly message.

THE CHAMBERED NAUTILUS

BY OLIVER WENDELL HOLMES

This is the ship of pearl, which, poets feign,
Sails the unshadowed main,—
 The venturous bark that flings
 On the sweet summer wind its purpled wings
 In gulfs enchanted, where the Siren sings,
And coral reefs lie bare ;
Where the cold sea-maids rise to sun their streaming hair.

Its webs of living gauze no more unfurl ;
Wrecked is the ship of pearl!
 And every chambered cell,
 Where its dim dreaming life was wont to dwell,
 As the frail tenant-shaped his growing shell,
Before thee lies revealed.—
Its irised ceiling rent, its sunless crypt unsealed!

Year after year beheld the silent toil
That spread his lustrous coil;
 Still, as the spiral grew,
 He left the past year's dwelling for the new,
 Stole with soft step its shining archway through,
Built up its idle door,
Stretched in his last-found home, and knew the old no more.

Thanks for the heavenly message brought by thee,
Child of the wondering sea,
 Cast from her lap, forlorn!
 From thy dead lips a clearer note is born
 Than ever Triton blew from wreathed horn!
While on mine ear it rings,
Through the deep caves of thought I hear a voice that sings:—

“Build thee more stately mansions, O my soul,
As the swift seasons roll!
 Leave thy low-vaulted past !
 Let each new temple, nobler than the last,
 Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea!”

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